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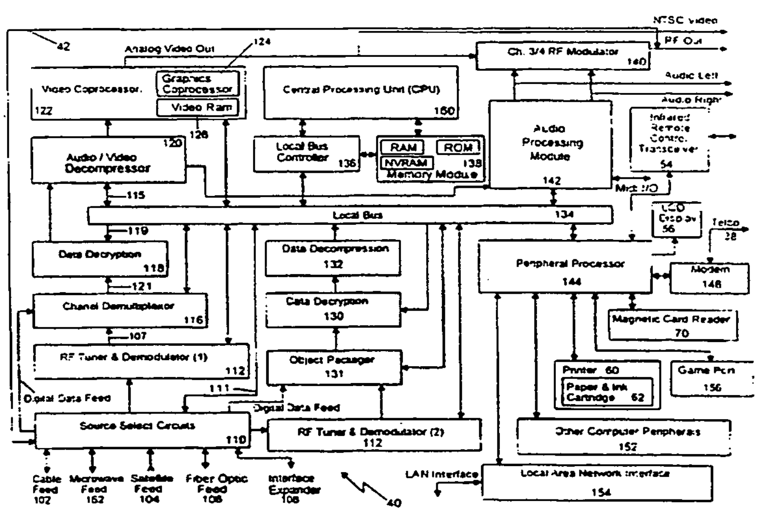

(57) Abstract

An interactive television distribution system which includes a central processing station (20) having a source of programming, a central minicomputer (800) configured to manage a variety of interactive television applications including digitally encoded video, and audio signals and other digital data including but not limited to computer programs, commands, operating systems, instructions, database, financial transactions, coupon distribution, shop-at-home applications, theater and sporting event ticket distribution, banking and financial services, video game support, and message exchanges, a receiver/processor unit (40) consisting of a central processor (160), random access memory, system software ROM (138), user interface (54), liquid crystal display (56), and a graphics generator (124). Primary features of the system include a printer (60) and card reader (70) together with supporting processing electronics and system management software to enable the production of coupons and other documents on demand in the home of a user, and to download credit card data directly into the system.

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INTERACTIVE COMMUNICATIONS SYSTEM WITH DATA DISTRIBUTION

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of United States patent application Serial No. 08/070,814, filed June 3, 1993, entitled INTERACTIVE VIDEO SYSTEM WITH DOCUMENT DISTRIBUTION; and also a continuation-in-part of United States patent application Serial No. 08/158,293, filed November 29, 1993, entitled INTERACTIVE VIDEO COMMUNICATIONS SYSTEM WITH DATA DISTRIBUTION.

The present invention relates to software and hardware for the complete support of interactive video programming in an environment which also supports the remote generation of hard copy documents, and high capacity, efficient movement of data in object form.

More particularly, the present invention is adapted toward a distributed interactive television communications method and system that supports distribution of audio / visual information and data over existing television distribution pathways.

The invention includes a specialized tuner and control computer or receiver unit positioned adjacent to the user's television to: (i) receive and decode digital and analog signals, and thereby serve as an access point for pay per view television programming; (ii) generate computer graphics and multimedia signals for display; (iii) accept user input through a graphical user interface for display; (iv) encode and transmit user generated command sequences and user inputs including credit card data; (v) print coupons and other hard copy outputs; and (vi) execute computer software for service as an integrated home data processing center.

The invention provides for a video and data transmission system which transmits digital commands, and data in a novel information format on existing television distribution pathways and which utilizes advanced compression and sequencing to efficiently distribute such data to many receivers simultaneously. The information format is usable on a plurality of broadcast bands and modalities. Additionally, virtual channel maps can be used to control the mapping of television programming and would be transmitted to

receiver units. The receiver units are adapted to selectively extract information from a continuous broadcast stream as needed.

The receiver units are adapted to receive digitally encoded and possibly encrypted television signals that are compressed and multiplexed with other like television signals. Any number of independent receiver units can select the same or different portions of the broadcast information simultaneously. In this way, interactive integrated receiver tuners with relatively small memory capacities and limited processing capabilities can utilize data transmitted from a large central data base at very low cost utilizing existing television distribution networks, in addition to emerging distribution technologies like Direct Broadcast Satellite (DBS), and fiber optics.

Over the last twenty years, the popularity of television programs which require users to contact the broadcaster through conventional telephone lines speaks to the growing demand for interactive television applications.

Advertisers appreciate the marketing power of immediate response television sales programs which offer the opportunity to reach mass numbers of consumers and close actual sales with these customers on a real time basis. Reports of sales in excess of one million dollars of merchandise per hour have been reported with respect to shop-at-home programs. However, these systems suffer from the inability of a consumer to respond easily and efficiently.

Contact must often be made through the intervention of a human operator who guides inexperienced users through the shop-at-home process. Credit card information is revealed over the telephone to salespeople who then have the opportunity to misuse that information. In addition, such systems suffer from an inability to offer written coupons or other sales inducements to the customer. All of these factors combine to lower overall margins and reduce profitability of interactive television marketing in general.

In addition, the invention offers a unique pathway for the distribution of data. Existing cable television lines,

for example, provide a broad bandwidth pathway for the distribution of data. Terrestrial transmission in the UHF band is an attractive pathway for the transmission of digital television and data signaling. DBS and microwave link television networks also provide attractive data pathways.

With the advent of digital television signals moving over these pathways, significant bandwidth is being released for additional uses by broadcasters. Where one 6 MHz analog channel previously carried only the video and audio for one television station, the new digital channels will carry four to six such stations in the same 6 MHz frequency bandwidth. Thereby, a cable television operator having 50 analog channels will have over 200 digital channels available. This increased usage of existing bandwidth provides a unique opportunity to take advantage of existing distribution systems to distribute non-television data.

The present invention is directed to a sophisticated overall system to widely distribute digital data and collect consumer information utilizing existing television and communication networks. The present invention is intended to be a fully automated system capable of carrying out its objectives without the benefit of human intervention. It consists of: (i) a central processing station capable of receiving user inputs and requests and managing data flow out to a large number of receiver units; (ii) a novel information format or data highway structure which ensures that data is transmitted to remote locations quickly and efficiently and with a high degree of security; and (iii) an Interactive Integrated Receiver Tuner (IIRT) for generating user requests, managing inbound data flow, and providing a fully functional device management platform for a variety of home electronics. A bi-directional infrared port is provided with the IIRT for remote controllers and connection to other computing devices. In addition, a magnetic card reader is provided with the IIRT to enable a user to input credit card information by physically taking a bank credit card and sliding it through a designated slot on the surface of the

IIRT. This enables the automatic processing of credit card information without further input from the user.

This invention utilizes a novel information format based on an object oriented class that when applied to the discipline of data distribution systems supports an unlimited number of data constructs and types, see Figure 10. The problem with the previous art in this field is that the data models were very monolithic by nature, i.e., they were not flexible in the kind or type of transported data content. This invention solves this problem by defining a base class that contains methods and objects. By applying this paradigm to a data highway, the content and function of the highway is extensible, thus surpassing the static nature of the previous art in the field.

Several attempts have been made in the past to address the need for an improved interactive video distribution system. A prior U.S. Patent to Rhoades, No. 5,051,822 discloses a telephone access video game distribution system. The system consists of a home computing assembly and a central remote game storage center. Software video game programs are transmitted via a modulated carrier to the subscriber and consist of executable object code transmitted over standard cable television lines. Program selection is controlled by a remote game storage center and billing is performed automatically over telephone lines. The video game software is downloaded into a home computing assembly over standard cable television links wherein it may be accessed by the user. Each time the game is accessed, a billing signal is transmitted to the remote game storage center. This system is limited to video game and other software applications. It utilizes a direct transfer of the software over the cable television distribution system. Rhoades suffers from the inability to distribute large quantities of information to many users simultaneously. In addition, Rhoades does not include any document delivery capability.

A further example of prior art systems is found in the U.S. Patent to Pocock, et al, No. 5,014,125 directed to a television system for the interactive distribution of

selectable video presentations. The Pocock system is intended to be a still image television distribution system. Control signals are transmitted over telephone lines while video is transmitted over standard cable television lines. A viewer makes a selection of the program desired which is transmitted over the telephone lines. A central control location responds to viewers requests by transmitting desired video frames to frame gates located at strategic positions within the topology of the cable system. This effectively steers the still image television signal to the trunks that service the viewers location. In contrast with Pocock the present invention claims improvements over this previous art as it negates the need for frame gates to steer television signaling, thus reducing the cost and complexity of deploying such a system. The present invention also claims improvements over this previous art in that it is not limited to still frame video.

A still further example is provided in three related U.S. Patents to Abraham, Nos. 4,590,516, 4,521,806, and 4,567,512. The Abraham system is directed to a subscriber driven video distribution system in which a user interactively orders a video program over the telephone lines, subsequently, the program signal is transmitted over a standard cable television line at a prearranged time. The program is either received in real time or is stored in centralized distribution centers for redistribution over local cable television nodes at the prearranged time. This system is widely known as a "pay per view" system. An improvement on this prior art can be found in the present invention based on the use of real time compression / decompression technology. An improvement on this prior art can be found in the present invention which is not limited to distributing only television programming.

A still further example may be found in the U.S. Patent to Fernandez, No. 4,961,215 directed to continuous automatic radio distribution system utilizing telephone lines as a distribution medium. The radio data is transferred via modem or digital communication device over telephone lines to

remote locations where it may be used immediately or stored for later use.

A still further example of interactive television systems may be found in the U.S. Patent to Tindell, et al., No. 5,130,792 directed to the distribution of compressed video program files to remote stations where such programs are decompressed and replayed. An improvement on this prior art can be found in the present invention based on the use of real time compression / decompression technology. By negating the need for an onboard high capacity storage subsystem, the present invention is not structured using a store and forward architecture, thereby reducing the cost to the viewer by negating the cost of the associated high capacity storage subsystem.

Another prior art system is set forth in the patent to McCalley, U.S. Patent No. 4,829,372, 5,119,188, 5,191,410. McCalley discloses a system whereby compressed video and audio data is transmitted via cable television lines to subscribers television sets. Subscribers may scroll through information being transmitted to their televisions in the form of video with accompanying audio sequences. The present invention discloses improvements in the interactive nature of a home shopping system. Specifically, the present invention uses actual not simulated menus to allow the user to navigate the video mall. The viewer simply uses a remote control to access the functions of the IIRT, and can actually buy products by using the integrated credit card reading device. The present invention negates the need for a frame store unit and is not limited to still frame video presentations.

A still further example may be found in the U.S. Patent to Hoarty, No. 5,220,420 which discloses an interactive multimedia system with distributed processing and storage of video picture information and associated data and sound in nodes throughout a cable television distribution system. The present invention addresses structural differences and improvements over this previous art by negating the need for the store and forward of video picture information and associated data and sound in nodes throughout a cable

television distribution system. This improvement reduces the cost and complexity of the system thus reducing cost and increasing reliability for the viewer.

As will be understood, the system for providing interactive video programming with remote document generation of the present invention overcomes many of the disadvantages of the prior art. The difficulties and limitations suggested in the preceding are not intended to be exhaustive but rather among the many which may tend to reduce the effectiveness and user satisfaction with prior video distribution systems and the like. Other noteworthy problems may also exist. However, those presented above should be sufficient to demonstrate that prior interactive video systems appearing in the past will admit to worthwhile improvement.

SUMMARY OF THE INVENTION

In contrast to the prior art devices which have attempted to address the need for an improved interactive television system, the present invention is particularly, although not exclusively, adapted for use as an interactive television system which streamlines data transfer to remote television viewers and returns user inputs and offers the unique advantage of permitting the generation of hard copy documents remotely in the home of the viewer.

In the preferred embodiment, the present invention consists of an improved method and hardware for supporting interactive television including: (i) a central processing station capable of providing digital television transmission and digital command and data transmission; (ii) a remote receiver unit having

* processing and storage capability to extract interactive digital commands and or data from a digital television transmission and or digital data transmission,
* a digital television display support system with windowing and graphic overlay,
* capability for real time audio and video decompression,
* a user interface for transmitting user selection information and accepting credit card information,

* a printer station for generating hard copy documents in the home of a user that can be synchronized with a television event,
* a graphical user interface,
* a wireless remote controller,
* an interface for DBS,
* a low cost high speed digital expansion interface.

The present invention is adapted to be a wholly integrated system capable of supporting the entire cycle of interactive television including item or program selection, transmission, response and billing. The information formats or transmission protocols used are preferably, but not exclusively, directed to a unique digital scheme.

A primary advantage of the present invention is its ability to enhance interactivity between a viewer and the producer of a video program.

A further advantage of the present invention is its integrated design permitting all necessary functions including viewer purchases to be accomplished within a single automated system.

A further advantage of the present invention is its ability to produce hard copy documents in the home of a viewer.

A further advantage of the present invention is its unique data compression and transmission scheme.

A further advantage of the present invention is its unique reverse addressing scheme.

A still further advantage of the present invention is its adaptability to different broadcast methods within a single system. The present invention is capable of accommodating cable television, terrestrial, twisted pair hard line, fiber optic, DBS, and microwave distribution modalities.

A still further advantage of the present invention is use of individually addressable pixel bit map technology in a high quality graphics processing system to support refined graphics programming.

A further advantage of the present invention is its unique structures for packaging data.

A still further advantage of the present invention is its use of unique data interleaving methods to accommodate more efficient data distribution.

A still further advantage of the present invention is compact design and remote control operation.

A still further advantage of the present invention is the ease of maintenance to be performed by the user.

A still further advantage of the present invention is its ability to process consumer credit card information automatically.

A still further advantage of the present invention lies in the use of a distributed client / server processing system permitting system redundancy and facile expansion.

A still further advantage of the present invention lies in the versatile home receiver unit.

A still further advantage of the present invention lies in the home receiver unit's unique ability to boot its operating system from the network.

A still further advantage of the present invention lies in the unique object oriented base class that defines the most basic elements of the communication system.

A still further advantage of the present invention lies in the multitude of consumer choices for programming and services.

A still further advantage of the present invention lies in its ability to communicate to other devices using infrared communication links.

A still further advantage of the present invention lies in its ability to display digitally encoded television in real time.

A still further advantage of the present invention lies in the receiver unit's ability to execute personal computer software and games.

A still further advantage of the present invention lies in its ability to decode digital television and digital command and data transmissions simultaneously.

It is therefore a general object of the invention to provide a novel interactive television system with document

distribution capability or the like which will obviate or minimize the problems previously described with reference to the prior art.

It is a specific object of the invention to provide a novel interactive television system which includes advanced interactive and processing features.

It is another object of the invention to provide a novel interactive television system which includes the capability to produce system generated documents in the home of a user.

It is another object of the invention to provide a novel interactive television system which includes the capability to produce system generated documents in the home of a user synchronized with a television event.

It is still another object of the invention to provide a wholly integrated interactive television system which utilizes uniquely packetized data, data interleaving and digital compression in the same system.

It is still another object of the invention to provide a wholly integrated interactive television system which requires no human intervention in order to operate interactively.

It is a still further object of the invention to provide a novel receiver unit which includes a user friendly interactive method of operation and the capability to process credit card information.

It is a still further object of the invention to inject commands or digital codes into digital television streams.

It is a still further object of the invention to accept commands from a television data streams.

Other advantages and meritorious features of the present invention will be understood from the following description of the preferred embodiments, the appended claims, and the drawings, the brief description of which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Corresponding components in the various figures are either designated by the same reference numerals or if different reference numerals are used their relationship is identified in the text. The various objectives, advantages

and novel features of the invention will become more readily apprehended from the following detailed description when taken in conjunction with the appended drawings, in which:

Fig. 1 is a partial perspective and block diagram showing an overview of an interactive television system according to the invention;

Fig. 2 is a block schematic diagram of a central processing station in accordance with the invention;

Fig. 3 is a block schematic diagram of an Interactive Integrated Receiver Tuner (IIRT) in accordance with the invention;

Fig. 4A is a block schematic diagram of a source select circuit 110 for the IIRT shown in Fig. 3 in accordance with the invention;

Fig. 4B shows truth logic tables for operation of source select circuit 110 as set out in Fig. 4A;

Fig. 4C is a schematic for logic circuitry used to implement the source select circuit 110 shown in Fig. 4A;

Fig. 5 is a block schematic diagram of a video graphic subsystem in accordance with the invention;

Fig. 6 is a front plan view of a remote control unit according to the invention;

Fig. 7 is a flowchart showing an initialization process for booting an operating system from a central processing station to an IIRT in accordance with the invention;

Fig. 8 is a block schematic diagram of an object packager according to the invention;

Fig. 9 is a diagram showing a method for an interleaving scheme for ordering objects incorporating data in accordance with the invention;

Fig. 10 is a class diagram showing the base class structure for an object that travels through a communications network in accordance with the invention;

Fig. 11 is a class diagram showing the member object structure for a header object that travels through a communications network in accordance with the invention;

Fig. 12 is a class diagram showing the member object structure for a data object that travels through a communications network in accordance with the invention;

Fig. 13 is a flowchart for software used to generate a table of contents for data objects, and incorporate the generated table of contents in an operating system in accordance with the invention;

Fig. 14 is a flowchart for software used to size object data blocks and commence continuous downloading of data objects in accordance with the invention;

Fig. 15 is a flowchart for software used to accomplish continuous downloading of data objects from a central processing station to IIRT units in accordance with the invention; and

Figs. 16A-C are flowcharts for a method usable between a central processing station and an IIRT unit for requesting, delivering and paying for data in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a partial perspective and block diagram showing an overview of an interactive television system according to the invention is shown in figure 1. The interactive television system according to the invention shown in figure 1 is generally designated by reference numeral 10, and includes two major subsystems. One of these two subsystems is a central processing station 20 having a distribution interface for receiving television programming, such as from a satellite 24. The other of these subsystems is an Integrated Interactive Receiver Tuner (IIRT) unit 40, that is interconnected with the central broadcasting station 20 using a communications network or transmission modality. In practice there would be many IIRT units 40, though only one is shown in figure 1, and there could be multiple central processing stations 20 depending on functions and convenience, including the size of the customer system being served. Communications between a central processing station 20 and IIRT units 40 is shown in figure 1 as being provided over a coaxial cable television network 32,

but such communications for the invention can also be provided over microwave, satellite 24, fiber optic 33, telephone with modem, i.e., telco 38, or any other communications network capable of passing television signals. Many types of variations in the communications network are also permissible. For example, depending on topology of the cable television network 32, it can incorporate use of Asynchronous Transfer Mode (ATM) and be usable for the invention.

The central processing station 20 is provided with automated data processing equipment having sufficient speed and capacity for supporting real time interactive transmissions according to the invention. Included, for example, are a plurality of data servers 832 ("A" through "X" as shown, but can be any number), see figure 2, that are used to originate high speed data streams. These data servers 832 -- the number and capacity of which are selected to satisfy requirements for providing high speed data streams as dictated by any particular interactive television system 10 -- use known Winchester disk drives as manufactured by Micropolis having several gigabytes of capacity. Management of high speed data stream processing and transmission for the invention is accomplished with interface and management electronics controlled by master computer 800. Additionally, a multitasking operating system, e.g., UNIX, VAX VMS or WINDOWS NT, is utilized by master computer 800 to provide necessary data processing and transmission circuit control for supporting real time transmission of both television programming and interactive data programming in accordance with the invention. As used here, interactive data programming includes data and information. For example, data and information can include commands and/or software programs and/or bit map images encoded within a data stream, multimedia presentations, audio, video, sales catalogs, stock listings, computer software, video games, etc. As long as the input for interactive data programming can be formatted as digital signals, the interactive television system 10 can support interactive transmission and processing. Master

computer 800 accordingly needs to be a computer capable of multitasking functions, e.g., it can be a VAX or ALPHA computer system as sold by Digital Equipment Corp., a SPARC 10 computer system as sold by Sun Microsystems Inc., a fault tolerant computer system as sold by Tandem Computers Inc., or equivalent of these computer systems.

Television signals are provided to the central processing station 20 via distribution interfaces, such as CATV 30 or satellite 24. These signals in most cases are digitized at the central processing station 20. The digitized television signals are then transmitted from the central processing station 20 in combination with digitized interactive data signals over a transmission modality, such as a cable network 32. Any transmission modality capable of passing television signals can be used with the invention. Illustrative interfaces for such transmission modalities are shown in figure 2 for the central processing station 20 and include interfaces for a satellite dish 812, and an expanded communications interfaces 808. A satellite transponder 858, fiber optic interface 860, terrestrial interface 862, packet radio interface 864, cellular interface 866 and a telephone (hereafter telco) interface 868 are all shown for the expanded communications interfaces 808. Each of these interfaces can provide interconnection to a transmission modality that would enable the central processing station 20 to communicate with IIRT units 40. These are fully automated interfaces permitting communication without human intervention, and are known circuitry used for inputting such bi-directional signals to processing and transmission systems.

Interconnected between the expanded communication interfaces 808 and the master computer 800 can be credit processing gateway 872, order fulfillment gateway 874, and/or other goods & services gateway 876. Each of these gateways is providing a functional capability using known commercially available equipment. For example, credit processing gateway 872 can include an interconnect using telco 38 to credit verification equipment operated by TRW, Inc. These gateways

are used for augmenting available services using commercially available equipment.

It is known that all transmission modalities are limited in the amount of effective bandwidth that can be passed. In many cases the amount of bandwidth a transmission modality can pass is completely consumed with analog television signals. A requirement, however, of the interactive television system 10 is that no previously available television channel be precluded from passage over the selected transmission modality, and that substantial additional quantities of interactive data be passed over the same selected transmission modality. Accordingly, the invention includes features providing for real time transmission of substantial additional quantities of data to support interactive features over transmission modalities that previously had their bandwidth capacities saturated with television channels. To achieve this capability the invention reduces the bandwidth required for transmission of audio and video television signals and utilizes the residual bandwidth to transmit interactive data signals between the central processing station 20 and IIRT units 40 without disrupting or in any fashion interrupting prior existing television services. This capability is achieved at the central processing station 20 through real time analog to digital conversion of video and audio television signals followed by compression of the digitized television signals for transmission. Such analog to digital conversion in combination with compression reduces video and audio television signal transmission bandwidth requirements by at least three-quarters. Typically video and audio signals for one television channel, when transmitted in analog form, require a bandwidth on the order of 6 MHz. Therefore, using analog to digital conversion in combination with compression and also using properly selected modulation techniques such as 256 Quadrature Amplitude Modulation (QAM) to achieve high data symbol rates provides substantial reductions in required transmission bandwidths per television channel. These bandwidth requirement savings are more than adequate in

combination with other features of the invention for transmitting interactive data while still providing complete television services.

Even further enhancing interactive data handling and transmission capabilities of the invention is the fact that the software operating system is based upon object orientation. Thus, the interactive television system 10 according to the invention utilizes an object oriented class for transporting interactive data over transmission modalities. As such an unlimited number of interactive data constructs and types can be supported using object oriented classes of the invention. These capabilities are achieved because, as is known, object orientation provides a better paradigm, and tools for modeling the real world to achieve more efficient results over previous models. Prior approaches to transmitting data were static because the transport systems were forced to move the data in fixed sized packets. Thus, prior data exchange systems were severely limited in their capacity to process and transmit a wide range of data types because each prior system could only be efficient for a particular selected data type, e.g., video games. If a data exchange system were optimized for video games, for example, it would not provide efficient data processing or transmission for video conferencing or other data intensive applications. As such, this invention using modifiable object orientation uniquely recognizes and addresses the need for dynamic data structures to support multiple application needs. It also supports throughput capabilities for utilized communicating devices, and adapts to available network bandwidths and other variables that effect efficient data transport. The invention can efficiently manipulate any size data structure because the object oriented base classes used for the invention can be adjusted in size.

For the invention, fields labeled object entities are used to contain interactive data. The field sizes for object entities are not statically fixed as explained above but are dynamically adjusted to facilitate rapid data transmission to

all IIRT units 40 for essentially on-demand service in response to individual user requests as will be explained below. Allocation of object entity sizes is controlled using data stored in a system table accessed using master computer 800. Data in this table is indexed according to data class and sub-class; also included are object entity size data for particular transmission modality conditions such as usage. Allocating object entity sizes as a function of interactive data type and transmission modality, allows the interactive television system 10 in combination with the selected transmission modality to operate efficiently under all conditions. Since data for object entity sizes are stored in a lookup system table as opposed to hard coded into the operating system, the invention provides optimum performance for all object entity types.

In operation user requests are received and data transmissions are provided by the central processing station 20. Interactive data transmissions can, as discussed above, include software and other data base information, i.e., catalogs, coupon distribution, shop-at-home applications, theater and sporting event ticket deliveries, banking and financial services, video game distribution and support, electronic mail, and virtually any other distributed interactive data application.

As shown in figure 2 the preferred embodiment for central processing station 20 incorporates an input from satellite dishes 812 for receiving television programming, interactive data, and other signals. Also available for input to the central processing station 20 is the satellite transponder 858 included in expanded communications interfaces 808. Other inputs from different sources could be used. However, those shown in figure 2 are considered adequate to support the interactive television system 10 according to the invention. Satellite dishes 812 receive signals from satellite 24, which can be in geosynchronous orbit. Signals received using satellite dishes 812 are passed to a satellite converter circuit 814 for conditioning. The satellite converter circuit 814 is known circuitry as used in typical

television receiving stations. Those portions of the received signal in analog formats are passed through RF tuner demodulators 816 for further conditioning into individual channel signals. The RF tuner demodulators 816 can be can be purchased from Scientific Atlanta, or equivalent. Each channel signal is then passed to an analog to digital converter 818 capable of real time analog to digital conversion of audio and video television signals. The analog to digital converter 818 can be a device such as those manufactured by DiviCom, Inc. of Milpitas, California, or equivalent. The number of analog to digital converters 818 and associated supporting circuitry corresponds to the number of channels the central processing station 20 will accommodate. This number is selectable depending on application, and in fact the number of analog to digital converters 818 and associated supporting circuitry can be greater than the initial number of television channels serviced so as to provide expansion capacity. Each channel of digitized signals is then passed for compression to an audio video compression circuit 820, such as are available from DiviCom, Inc. of Milpitas, California, or equivalent. To assure security and prevent program pirating, the digitized and compressed signal can then be passed through a data encryption circuit 822, such as a DES circuit, Clipper circuit, DSD circuit as supplied by Teledyne, or equivalent, prior to retransmission from the central processing station 20. As broadcasters initiate use of digital transmissions, the need for analog to digital signal conditioning will diminish. The digitized, compressed and encrypted signals are then combined using channel multiplexer 830 which is a device as used for known television broadcasting and are available from DiviCom, Inc. of Milpitas, California and from other suppliers. The multiplexed signals are impressed on a carrier using RF modulator 848. For a preferred embodiment using a coaxial cable transmission modality to transport a high volume of information, a 256 Quadrature Amplitude Modulator (QAM) RF modulation scheme can be used. RF modulators providing 256 QAM modulation are available from

Applied Signal Technologies, Inc., of Sunnyvale, California. Since different modulation schemes provide better service depending on system parameters such as transmission modality, the interactive television system 10 of the invention can use what ever modulation scheme provides the best service. For example, when a terrestrial transmission modality is utilized, a VSB modulation scheme can be employed. Fully capable VSB modulators can be obtained from Zenith Data Systems. The above-described processing of received analog television signals is managed by the master computer 800 using gating signals that are passed using gate connection 880 to channel multiplexer 830 and gate connection 884 to RF tuner demodulators 816.

The central processing station 20 is also capable of handling those situations where previously digitized television signals are received by satellite dishes 812. In such situations the digitized signals are passed from RF tuner demodulators 816 to channel multiplexer 878, that can be of the same type and therefore equivalent to channel multiplexer 830, and the recombined digitized signals are then passed as shown in figure 2 to an RF modulator 848 for retransmission. Again, the method for signal processing is controlled by the master computer 800 using gating signals. Here gating signals are passed between the master computer 800 and channel multiplexer 878 over gate connection 882.

In operation, the master computer 800 allocates certain channels for television programming and other channels for bi-directional interactive data transmission. For example, the master computer 800 can use specific address information for particular IIRT units 40 to direct selected signals to those IIRT units 40 alone.

To perform its functions master computer 800 utilizes mass memory storage devices, not shown, that can be a bank of Winchester disk drives, optical disk media, or other high speed low cost mass storage systems. Stored on the mass memory storage devices can be a variety of software programs, data base information, games, customer information for the IIRT units 40 of the interactive television system 10, still

or moving images, or any other digitized interactive data to be transmitted over the interactive television system 10 of the invention. Additionally stored on the mass memory storage devices is the operating system for both the central processing station 20 and the IIRT units 40. The stored operating system is booted to the IIRT units 40 as explained below.

Individual users of the interactive television system 10 are provided with an IIRT unit 40 connected to a conventional television receiver 26. A remote control unit 52 can be used for operating the IIRT unit 40. Though a cable network 32 with a CATV Headend 30 is shown in figure 1 as being capable of supporting all communications between IIRT units 40 and the central processing station 20, it is again emphasized that any other communications network or transmission modality system capable of passing digital signals and television signals can be used including telco 38.

An IIRT unit 40 according to the invention is shown in block schematic diagram form in figure 3. Principal portions of the IIRT unit 40 include a central processing unit (CPU) 160 provided with supporting electronics in the form of a local bus controller 136. This local bus controller 136 can be a 82420EX PCIset as sold by Intel, or equivalent. Additionally, there is a memory module 138 that can include Random Access Memory (RAM) having a two megabyte capacity, Read Only Memory (ROM) having a 64k byte capacity and data access memory in the form of a Nonvolatile Random Access Memory (NVRAM) having a 2k byte capacity such as a DS-1642 as sold by Dallas Semiconductor, or equivalent. The CPU 160 is coupled using the local bus 134 to a video coprocessor 122 that can include a graphics coprocessor 124, such as are available from Texas Instruments and S3 Corp., or equivalent, and a video Random Access Memory (RAM) 126, such as are available from Texas Instruments, or equivalent. The CPU 160 can be a 6502 as sold by Signetics, a A80486DX as sold by Intel, or a PowerPC601 as sold by IBM Corporation, or equivalent.

Principal advantages of the IIRT unit 40 according to the invention are its capabilities to simultaneously process large amounts of interactive data and television data in real time without requiring sophisticated and expensive circuitry thereby reducing cost and maintenance requirements for the many IIRT units 40 that would be included in an interactive television system 10. For example, the IIRT unit 40 though performing sophisticated processing for a multitude of signals does not include a mass memory.

From a system perspective, substantial cost savings can be realized because much of the circuitry incorporated in the central processing station 20 and the IIRT units 40, though interconnected in unique arrangements to perform novel functions, is known and readily available from multiple sources.

As an example of reducing hardware requirements for the IIRT units 40 is the fact noted above that there is no requirement for incorporating any mass memory capability in the IIRT units 40. In spite of the extensive data storage and processing capabilities included as part of the central processing station 20, e.g., mass memory storage devices included for the master computer 800, the IIRT units 40 operate effectively without mass memory capabilities while still being capable of real time processing of all received signals because interactive data is continuously downloaded from master computer 800. Using continuous downloading provides essentially on-demand services. As implemented for the interactive television system 10 of the invention, continuous downloading includes segmenting digitized data for continuous broadcasting to IIRT units 40. This continuous broadcasting is not done so that all data for a single interactive program is broadcast in an uninterrupted stream followed by continuous broadcasting of all data for another interactive program and so forth. Instead, objects from different interactive programs are interleaved during continuous broadcasting, or continuous downloading. For example, if three interactive programs are to be broadcast, the first object to be broadcast could be for interactive

program one, the second object to be broadcast could be the first object for interactive program two, and the third object to be broadcast could be the first object for interactive program three. This ordering would continue for second, third and follow-on objects for each interactive program. When received by IIRT units 40, only those objects for interactive programs selected by each IIRT unit 40 would be processed. Each IIRT unit 40 would reject objects for interactive programs not selected by the end user, and or authorized by central processing station 20 for reception by an IIRT unit 40. Thus, each IIRT unit 40 will process signals for fewer interactive programs than broadcast because objects for multiple interactive programs are interleaved during continuous downloading. Individual IIRT units 40 will therefore not be saturated by the continuous stream of interactive data being broadcast.

Even further enhancing the invention's data handling capacities is inclusion of multiple channels for each IIRT unit 40. A single channel embodiment is feasible but, as shown in figure 3, the IIRT units 40 for the preferred embodiment include twin channels as represented by signals passed to RF tuner & demodulator (1) (element 112) and RF tuner & demodulator (2) (element 112) from source select circuits 110. This invention, however, is not limited to only twin channels because more than twin channels can be included depending on system requirements. As channels are added, system capacity increases; however, so also does cost and complexity.

Incoming signals to IIRT unit 40 are received at source select circuits 110 that is provided with interfaces to cable feed 102, microwave feed 162, satellite feed 104, fiber optic feed 106, and an interface expander 108. The interfaces identified in figure 3 are not an exhaustive set of acceptable interface feeds for the invention but are representative. Adaptability for additional interfaces in fact is in part provided for via interface expander 108. Source select circuits 110 includes electronically controlled bridges that permit reception and routing of signals from any

input. Specifically included in source select circuits 110 is a cable television interface tuner selector, a satellite interface tuner selector and a digital data stream router as shown in the block schematic diagram set out in figure 4A. Also shown in figure 4A is a RF modulator 848 having an output to cable feed 102. This RF modulator 848 is used to impress interactive data on a carrier for transmission from IIRT units 40 to the central processing station 20. Though shown with its output connected to cable feed 102, the RF modulator 848 can also have its output connected to any of the other available transmission modalities depending on which one is being used for bi-directional interactive data transmission. The RF modulator 848 is equivalent to that used for the central processing station 20.

A schematic of circuitry repeated for every transmission modality input to the source select circuits 110 is set out in figure 4C. In particular, the circuitry shown in figure 4C is labeled with inputs and outputs as it would be for incorporation in the digital data stream router, and is in fact duplicated in the digital data stream router for both the fiber optic 106 and interface expander 108 inputs. Outputs from these circuits as shown are directed to either the object packager 131 or the channel demultiplexer 116. The circuitry consists of a pair of AND gates 190, such as those incorporated in a TTL 7408 integrated circuit, or equivalent. Control of this AND gate 190 circuitry to direct routing of input signals is accomplished in accordance with logic as set out in figure 4B for the identified example. Logic signals provided to the identified select inputs are sent via local bus 134 from CPU 160, and so depending on provided logic signals the received data input signals can be directed to either the object packager 131 or the channel demultiplexer 116, or both. Control signals are received by each IIRT unit 40 from master computer 800 of the central processing station 20, and are decoded by CPU 160 for the purpose of providing logic signals for selecting the proper output port from the source select circuits 110.

Both the cable television interface tuner selector and the satellite interface tuner selector, as incorporated in the source select circuits 110, include AND gate 190 circuitry as shown in figure 4C. In the case of such circuitry for the cable television interface tuner selector and satellite interface tuner selector the outputs are to the RF tuner & demodulator (1) (element 112) and the RF tuner & demodulator (2) (element 112) thereby expanding the signal handling capacity of IIRT units 40. Gating for this circuitry again is provided from CPU 160 via local bus 134, and the controlling logic is identical to that set out in the truth logic table presented in figure 4B.

All signals provided to IIRT units 40 may not be transmitted in digitized form. For example, analog television signals may be passed to IIRT units 40 through cable feed 102 or any of the other transmission modality inputs. In such situations a filter circuit can be used to pass the analog television signals to output conductor 42 for feeding the RF out terminal of the IIRT units 40 as shown in figure 3. For such an example, the digitized television signals are passed to the source select circuits 110. This filtering circuitry can be provided for any or all of the other transmission modality interfaces depending on anticipated need.

Previously multiplexed signals directed from the source select circuits 110 to the channel demultiplexer 116 for separation into individuals channels for each signal stream. The channel demultiplexer 116 can be a DMX-2000 as sold by DiviCom, Inc., Milpitas, California, or equivalent. The demultiplexed channels are then passed to a data decryption circuit 118, that can be a DigiCypher II descrampler as sold by General Instruments Corporation, Chicago, Illinois, or equivalent. Now the demultiplexed and decrypted signals are passed to a video decompressor circuit 120, that can be a SD4 as sold by C-Cube Microsystems, Milpitas California, or equivalent, for video signal processing, and a CS4290 as sold by Crystal Semiconductor Corporation, or equivalent, for audio signal processing. The audio/video decompressor

circuits 120 can utilize MPEG 1 and 2, Digicipher 2, JPEG, or other standards as dictated by a condition signal provided from the central processing station 20 within a Table Of Contents (TOC) that is further discussed with respect to software shown by flowcharts in fig. 13, as downloaded to the IIRT unit 40. Now the demultiplexed, decrypted and decompressed signals are passed to the video coprocessor 122 that includes a graphics coprocessor 124 and a video RAM 126. The graphics coprocessor 124 can be a programmable DSP such as a TMS 34010 as sold by Texas Instruments, or equivalent, and the video RAM 126 as sold by Texas Instruments, or equivalent. From the video coprocessor 122 the signals are passed through a channel 3/4 RF modulator 140 so the signal can be viewed and heard on a conventional analog television receiver 26 tuned to either channel 3 or 4. Again, the channel 3/4 RF modulator 140 is a commercial device available from multiple sources.

As included in the IIRT units 40, the channel demultiplexer 116, data decryption circuit 118, audio/video decompressor 120, and video coprocessor 122 with its graphics coprocessor 124 and video RAM 126 are all conditioning previously digitized television signals for viewing and hearing using conventional analog television receivers 26. Not only would the cost and complexity of IIRT units 40 be reduced if these signal conditioning functions were performed with circuitry included in television receivers, but the utility of the television receivers would also be increased as broadcasters initiated digitized transmissions that could be directly received. A schematic diagram showing circuitry that could be included in television receivers for so conditioning previously digitized television signals is shown in figure 5. For this circuitry shown in figure 5, the output of the RF tuner & demodulator 112 in the IIRT unit 40 is directly provided by conductor 107 to a demultiplexer & decryption engine 119 in the television receiver instead of the data decryption circuit 118 shown for the IIRT unit 40 in figure 3. The demultiplexer & decryption engine circuits 119 can be a combination of channel demultiplexor 116 and data

decryption circuit 118. From the demultiplexer & decryption engine 119 the television signal is passed to an audio/video decompressor 120 that can utilize MPEG 1 and 2, Digicipher 2, JPEG, or other standard as dictated by a condition signal 115 provided from central processor 125. Bi-directionally connected to the audio/video decompressor 120 is a video decoder RAM 127 which can be a commercially available VRAM as are known. The output of the audio/video decompressor 120 is a decompressed and decrypted video data steam passed to a digital video combiner 113 that can be a circuit comprised of known digital logic elements performing an OR function. The digital video combiner 127 is incorporated as part of a video coprocessor 122 that is functionally equivalent to the one shown in figure 3 for the IIRT unit 40. A graphics video data stream is provided from the graphics coprocessor 124 to the digital video combiner circuit 113 which combines it with the decompressed and decrypted video data stream from the audio / video decompressor 120. Bi-directionally interconnected to graphics coprocessor 124 is a graphics video Random Access Memory (RAM) 130 that can be a commercially available VRAM as are known. Controlling the graphics coprocessor 129 through a bi-directional interconnection is the control processor 125 that can be any of a 6502, 8051, 6800, Z80 or other known equivalent micro processor or micro controller with at least an eight bit data bus.

An output of the digital video combiner 113 is provided to an NTSC video generator 133, which can be a BT 851 as sold by Brooktree Corp. of San Diego, California, or equivalent. From the NTSC video generator 133 an analog video out signal is provided for display on the cathode-ray tube of the television receiver. The analog audio output is provided from the digital to analog converter 114 that can be a CS4290 as sold by Crystal Semiconductor Corporation, or equivalent, for audio signal processing. Input to the digital to analog converter 114 is provided from the audio/video decompressor 120.

Returning to the IIRT unit 40 shown in figure 3, there are further processing electronics provided to condition signals received from the central processing station 20 that are then combined with signals from interactive inputs. Specifically, an audio processing module circuit 142 that can be a CS4231 as sold by Crystal Semiconductor Corporation, Austin, Texas, or equivalent is included to support signals from interactive ports included as part of the IIRT unit 40. This audio processing module circuit 142 includes an audio coprocessor, digital to analog and analog to digital converter, audio mixer, audio synthesizers, and midi Input / Output (I/O) to support audio as well as physical interactive ports.

In addition to the audio processing module circuit 142, the IIRT unit 40 also includes a peripheral processor 144 for introducing user provided input interactive signals. The peripheral processor 144 can be a 68000 as sold by Motorola, or equivalent. Examples of home user provided input interactive signals to the IIRT unit 40 that can be supported by the peripheral processor 144 include:

- signals passed from a remote Local Area Network (LAN) that would be introduced to the IIRT unit 40 through a local area network interface 154 that can be an Advanced Micro Devices Am79C970; or
- signals from remote computer equipment, such as keyboards, that are introduced to the IIRT unit 40 through computer peripherals circuit 152, that can be a National Semiconductor 87334; or
- signals for playing electronic games, such as from joy sticks, that can be passed through game port 156; or
- signals from a magnetic card reader 70 for inputting credit card information; or
- signals can be provided by the home user through a conventional remote control 52 (see figures 1 and 6) communicating with the infrared remote control transceiver 54 that can be a National Semiconductor 87334.

The infrared remote control transceiver 54 can be capable of providing a bi-directional link for communicating with the

IIRT unit 40 and other like equipped devices. Bi-directional communications with the IIRT unit 40 using the peripheral processor 144 is also possible using modem 46 with telco 38. In particular this communications link over telco 38 can be used for data transmissions between IIRT unit 40 and the control processing station 20.

Additionally, the peripheral processor 144 can be used to provide information and data directly to the home user on a Liquid Crystal Display (LCD) display 56 that can be a Sharp Electronics Corp. LM40255, or through the printer 60 that can be a AXIOHM Inc. HTP-8050. All of these capabilities and others can be readily added thereby allowing the IIRT unit 40 to serve as an extensive and adaptable home electronics integration system. This capacity to provide home electronics integration system capability is achieved not only by providing interfaces for facsimile machines, home stereos, Compact Disk (CD) players, Video Cassette Recorders (VCR) and computer equipment such as personal computers, disk drives, keyboards and joy stocks, but also by providing interfaces that can be used to monitor / control security systems and household utilities such as water, gas and electricity.

To even further support interactive functions there is a capability to display graphics and other message formats on the television receiver 26 and LCD display 56 using signals from the IIRT unit 40. In this manner, the user is prompted through menus or other provided information to efficiently select in a user friendly fashion services available from IIRT unit 40.

In addition to mounting LCD display 56 on the IIRT unit 40, it can also be mounted on remote control 52, see figure 6. As so mounted, displayed information can easily be read by a user holding the remote control 52. Information from the IIRT unit 40 can be displayed on such a remote control 52 because the infrared remote control transceiver 54 provides bi-directional communications to and from the remote control 52. Control buttons 58 are provided on the remote control 52 to input data. Also provided on the remote control 52 is a

track ball 64, joy stick or equivalent that can be used to adjust positions of objects displayed on the television receiver 26.

As stated above, a magnetic card reader 70 can be interconnected to the IIRT unit 40 through the peripheral processor 144. Magnetic card readers 70, sometimes known as card swipe readers, commercially available. They transform magnetically coded information stored on credit cards to digital bit streams identifying the card owner's name, card number, expiration date, and other relevant information. Having a magnetic card reader 70 allows an IIRT unit 40 user to simply and accurately enter credit card information when making a purchase or paying a bill. The peripheral processor 144 receives the digital bit stream signal from the magnetic card reader 70, and in cooperation with the CPU 160, the IIRT unit 40 stores the signal in the RAM portion of memory module 138. The signal is then compressed and encrypted for transmission to the central processing station 20. This automatic and direct ability to download credit card information to the central processing station 20 reduces the risk of credit card fraud and misappropriation. The process for transmitting such data from the IIRT unit 40 to the central processing station 20 is discussed below.

Using the printer 60, it is possible to provide home users of the interactive television system 10 with printed documents including tickets and coupons. The printer 60, depending on selected equipment, which is unrestricted by the invention, can utilize dot matrix or other conventional printing techniques capable of producing letter quality print and graphics. For the preferred embodiment, the printer 60 is of standard design and is driven using conventional printer sequences. To substantially eliminate user maintenance obligations the printer 60 can utilize a paper and ink cartridge 62. Compact design can be achieved if printer 60 provides two to four inches of printing width. This amount of printing width provides sufficient space for producing coupons, tickets, receipts and other documents. Thus, documents ranging from coupons to lottery tickets, and

from receipts to messages can be conveniently produced for the home user.

Turning to software and methods employed for the interactive television system 10, the software utilized for initialization, including booting of the operation system to IIRT units 40, is now described with reference to figure 7. As stated above, the operating system for all IIRT units 40 is booted from the central processing station 20 every time an IIRT unit 40 is turned on. The process begins when the home user brings power to the IIRT unit 40 (Step 900) by, for example, activating a switch that causes electrical voltage and current to be brought to all IIRT unit 40 devices (Step 910). After powering up, the CPU 160 using data stored in the NVRAM portion of the memory module 138 directs the RF tuner & demodulator (2)(element 112) to be tuned for passing signals on the channel used by the central processing station 20 for transmitting the operating system. If for some reason the previously identified channel is not active, i.e., the operating system is not being downloaded on this channel, the RF tuner & demodulator (2)(element 112) is directed by the CPU 160 to tune to the next channel so an evaluation of whether that channel is active can be made. If that next channel is not active then the RF tuner & demodulator (2)(element 112) is directed to tune to the next channel until the active channel is obtained (912). Data for the operating system, which is continuously downloaded from the central processing station 20, is packaged in objects having a header identifiable by the object packager 131 in the IIRT unit 40. It is such identification by object packager 131 that is used to confirm a channel as being active. When an object is received by an IIRT unit 40 with an operating system header, the contained packaged data is loaded into RAM 138 (Step 914). Next a check of the booted operating system data is conducted to assure accuracy and authenticity of the received data. This check is accomplished using an algorithm stored in the ROM of the memory module 138 (Step 916). If the data fails to comply with the check, the process for downloading is repeated as shown in figure 7. In the

alternative, if the check is passed, the CPU 160 directs a jump to the operating system and IIRT unit 40 operations are begun.

It is seen from this discussion of how the operating system is booted to IIRT units 40 that the object packager 131 functions as a filter to identify objects received at both the IIRT units 40 and the central processing station 20. This identification is accomplished by reading each object header, which are described below. These object headers are coded using digital data incorporated in fields within the object. Exemplary circuitry for an object packager 131 is shown in block schematic form in figure 8. The specific example shows circuitry usable for reading four bit headers. The invention, however, is not so limited. Object hearers incorporating greater or lesser bit patterns can be accommodated by straight forward scaling of the suggested circuitry or its equivalent. As shown a received object header signal is input to a four bit parallel access shift register 90 that can be a Texas Instruments 74LS95. Concurrently the four bit pattern for the object header that is to be read is input from local bus 134 to a four bit parallel latched bus transceiver 92 that can be a Texas Instruments 74LS226. The outputs of the four bit parallel latched bus transceiver 92 and the four bit parallel access shift register 90 are input to a four bit magnitude comparator 94 that can be a Texas Instruments 74LS85. When the bit pattern for the selected object header as input to the four bit parallel latched bus transceiver 92 matches that of the input to the four bit parallel access shift register 90, the four bit magnitude comparator 94 outputs a signal indicating the selected object is being received, and is ready for further processing. In this fashion the IIRT units 40 and central processing station 20 can identify and pass objects for processing. Such reading and passing of identified object headers is accomplished in the central processing station 20 circuitry using an object packager 131, as shown in figure 8, or equivalent, that is included in the expanded communications interfaces 808. As so located,

received signals are read, identified and selectively passed after passing through the interfaces.

Whether objects contain operating system data or other interactive data, they are always transmitted in an interleaved fashion so as to accomplish continuous downloading according to the invention. The method for interleaving transmitted objects is depicted in figure 9. For purposes of explanation here, the upper portion of figure 9 shows three different interactive data Programs, i.e., A, B and C, all of which are to be transmitted from the central processing station 20. Also shown in the upper portion of figure 9 is the fact that the included interactive data is segmented and incorporated in objects 1, 2, 3, etc. for each Program. The lower portion of figure 9 shows an organization for interleaved continuous downloading transmission on a single channel according to the invention. In the case of this example, the interleaving technique positions object 1 for Program A to be transmitted first, and this transmission is immediately followed by object 1 for Program B, which is followed by object 1 for Program C, and so forth. According to this interleaved continuous downloading technique, no object from the same Program is transmitted immediately after a transmission of any other object for that same Program. Therefore, no IIRT unit 40, for this example, is required to download more than every third object on a channel. Irrespective of the example, moreover, no IIRT unit 40 is required to download two or more consecutively transmitted objects. All downloaded objects are followed in transmission by at least one object that is not downloaded. As explained above, use of this interleaved continuous downloading technique enables IIRT units 40 to accomplish real time processing of received data using cheaper and less sophisticated electronics than would be required for real time processing of interactive data continuously received for the same Program.

As identified above, the interactive television system 10 according to the invention utilizes object oriented classes for transporting interactive data over transmission

modalities. Accordingly, an unlimited number of interactive data constructs and types are supported by the unique object oriented classes of the invention. These capabilities are achieved using the unique object oriented classes of the invention because object orientation provides better paradigms and tools for modeling the real world to achieve better and more efficient results than do previous non-object oriented structures. A system, in general, must comply with four rules to be object oriented:

- Abstraction must be a characteristic used by each kind of object to distinguish it from all other kinds of objects. In terms of the invention, abstraction is initiated from the base class, see figure 10, because the base class includes the least common elements essential for constructing each kind of object that can be transported over a transmission modality.

- Encapsulation must be utilized so that elements of the abstraction are compartmentalized. For example, the invention uses an encapsulated object address 504 in the base class, see figure 10, for enabling proper receipt of an object over a transmission modality.

- Modularity must be a property of an object system permitting decomposition into a set of cohesive but loosely coupled modules. In terms of the invention, modularity is incorporated in the definition of the base class shown in figure 10 so it can be loosely and cohesively coupled to extended sets of objects that share a common structure and behavior, i.e., classes, through a relationship among classes, and also share the structures or behavior defined in other classes. These relationships are known as inheritance.

- Hierarchy must be utilized for ranking or ordering of abstractions within the system. Since the base class, see figure 10, is constructed using the minimum number of elements required for an object according to the invention, all subsequent classes are built from the base class. Such construction from a base class defines an hierarchy of objects. Inheritance, because of hierarchy,

enables code and structure sharing among objects, thus creating a source of reusable modules.

Prior approaches for organizing and transporting interactive data and information were static. Thus, prior interactive systems were severely limited in their capacity to process and interchange interactive data. The invention, however, is not so limited because of its use of object oriented base classes that can grow to include different kinds of objects for sharing. For example, polymorphism, as used in known object orientation technology, can be used for relating objects according to the invention from many different classes under a common superclass.

A class diagram showing a base class structure for an object that can travel over transmission modalities according to the invention is shown in figure 10. The object structures for the invention are assembled at the central processing station 20 using the master computer 800 or at the IIRT unit 40 using the CPU 160. After assembly using the master computer 800 or the CPU 160, the digital signals for the object are transmitted using shift register devices such as sixteen bit parallel in serial out shift registers, which can be 74LS674 devices as sold by Texas Instruments, or equivalent. For the IIRT unit 40 the sixteen bit parallel serial out shift register, used as an object creator 143, can be included between the local bus controller 134 and the RF modulator 848 as shown in fig. 4A; while, for the central processing station 20 this object creator 143 can be included with the master computer 800 as is the mass memory.

A separately encapsulated start of object identifier 502 and object address 504 are utilized by the present invention. Prior art directed toward transmitting data utilized a static or fixed size packet that had a non-adjustable capacity of, for example, 1024 or 4096 bytes. The present invention, however, is not so constrained because the object entity 506 is a variable size field capable of being tailored to system needs. Each object can thus have its object entity 506 size adjusted by master computer 800 or CPU 160 to optimize performance of interactive television system 10. Both the

prior art and the present invention utilize an error correction value 508 field, which can be a Cyclic Redundancy Code (CRC) algorithm, as are known, and a postamble or end of object identifier 510 field to complete the base class.

A member object structure class diagram for a header object according to the invention is shown in figure 11. The class diagram set out in figure 11 shows that the header object inherits properties from the base class shown in figure 10. The start of object identifier 502, shown in figure 11, enables an IIRT unit 40 or central processing station 20 to recognize the start of an incoming object as such, using an object packager 131 and is inherited from the base class shown in figure 10. For the header object shown in figure 11, the object entity 506 includes a variety of fields used to further identify an object so an IIRT unit 40 or central processing station 20 can selectively download a particular object entity 506. For example, using the IIRT address 248 field a preselected IIRT unit 40 can be identified for receiving an object entity 506 as shown in figure 11. Set out in the following table by field identification are the respective corresponding functions for an header object according to the invention.

Header Object

Field Identification	Function
Data Block Identifier 226	Provides identification information at the data block level.
Byte Count 228	Provides the number of bytes of data within the object.
Offset Address 230	Provides offset address from the beginning of the object, to permit flexibility in ordering of objects.
Encryption Type Code 232	Identifies type of encryption used to encrypt data block.
Compression Type Code 234	Identifies type of compression used to compress data block.

Data Class & Subclass 236	Identifies type of data being transmitted, e.g., object code, software code, graphic data for video display or hard copy printing, etc.
Next Object Channel 238	If a new channel needs to be used for transmitting the next object, e.g., to optimize system performance, this field identifies that information.
Next Object ID 240	Identifies the Object Address 230 for the next object.
Next Object Data Block ID 242	Identifies the Data Block Identifier 226 for the next object.
System Time 244	This field provides data to synchronize events to a common time base.
Receipt Validation Code 246	Provides the code information used for confirming receipt of a particular transmission.
IIRT Address 248	Identifies a preselected IIRT unit 40 for receipt of an object.
Command Code 250	Used to direct execution of system level commands, e.g., to print a document.
Command Data 252	Field contains data to implement execution of system level commands, e.g., data to be printed on document.
Future Use 254	Field reserved for future use.

Now, a member object class diagram for a data object according to the invention is shown in figure 12. Again, the class diagram set out in figure 12 shows inheritance of

properties from the base class shown in figure 10, and inheritance of properties from the header shown in figure 11. Within the data object is an object entity 506 containing a data header 222 and a data block 224. The data header 222 includes data block identifier 226, byte count 228, and offset address 230 fields. These data header 222 fields provide the information for achieving the functions as set out in the proceeding table. The data block 224 contains interactive data, and as explained above, is an adjustable sized field tailored to provide maximum system efficiency. Therefore, objects according to the invention are members of a base class and as such inherit dynamic object entity size.

Substantial transmission efficiency is achievable when interactive data is bi-directionally transmitted using both objects and interleaved continuous downloading according to the invention. This efficiency is realistically demonstrated by considering an interactive television system 10 that is capable of transmitting 24 megabits per second which is 3 mega bytes per second. Such transmission rates are reasonable when using presently available equipment. For the situation where 16 different start of object identifiers 502 are allocated at any one time (interleave factor of 16), and each object is sized at 2,048 bytes, there would be a 10.9 millisecond period required to transmit each individual object. Stated differently 92 individual objects for each of the 16 different start of object identifiers 502 would be transmitted every second. This number results from dividing the bytes transmitted per second by the product of the individual object size and the interleave factor. Assuming a system overhead of 10 percent for non-interactive data in each object, which may be high, and an interactive data stream 350 K bytes long, which is the size of a typical dictionary in a word processing program, a period of 33 seconds would be required to transmit the 350 K byte stream along with a similar amount of interactive data for the other 15 sets. This example illustrates the reason why the invention can effectively be used as an on-demand interactive

system for bi-directional transmission of substantial amounts of interactive data.

Referencing figure 13, a flowchart for software used for preparing interactive data for transmission in object form over transmission modalities is shown. This software is used to collate information from source object files for interactive data to be transmitted including: start of object identifiers 502; encryption type codes 232; compression type codes 234; and data class & subclasses 236 (see figure 11). Execution of the software is performed using master computer 800 in the central processing station 20 and results are transmitted to CPU 160 in IIRT unit 40.

To begin operations using the software all databases or source object files containing information regarding interactive data to be transmitted are opened (Step 202).

After opening these databases for reading, a list is generated (Step 204) of all enabled files including those from gateway streams, i.e., credit processing gateway 872, order fulfillment gateway 874, and other goods & services gateway 876 (see figure 2). This listing from enabled source object files now includes at least: sufficient information for writing start of object identifiers 502; encryption type codes 232; compression type codes 234; and data class & subclasses 236 (see figure 11).

Using this list, a Table of Contents (TOC) file (Step 208) is written and used by master computer 800, and is continuously downloaded to all IIRT units 40. At this point operation of the software described by the flowchart set out in figure 13 is complete.

Next master computer 800 uses software as described by the flowchart in figure 14 for preprocessing interactive data for transmission in object form in an interleaved continuous downloading fashion as illustrated in figure 9. First, the TOC 208 from Step 208 shown in figure 13 is loaded into the memory buffer (Step 522) of master computer 800. This memory buffer is then scanned and all listed objects are opened for reading including TOC file 208 (Step 524). A header object is next generated (Step 526) for each of the opened files.

Now that header objects are generated, the master computer 800 using object data class & subclasses 236 listed in TOC 208 references system tables stored at master computer 800 to determine optimum data block 224 sizes (Step 527). This is a look-up process with optimum data block 224 sizes listed in the system tables as a function of operating conditions.

The starting and ending offset addresses 230 for each object data block 224 is now generated in list form (Step 528). Finally, a file titled DATABLKS.DAT containing each object header, followed by the list of beginning and ending data block offset addresses 230 for each object is generated and saved in memory (Step 530). At this point operation of the software described by the flowchart set out in figure 14 is complete.

Objects are now available for transmission and must be interleaved in accordance with the organization described in figure 9. To accomplish this task, software as described by the flowchart shown in figure 15 is used. First, the DATABLKS.DAT file, from Step 530 in figure 14, is loaded from disk (Step 302). Now sufficient memory capacity must be allocated (Step 304) to accommodate a list large enough to point to all header objects and data blocks 224 that were loaded using the DATABLKS.DAT file in Step 302. With this memory capacity available, the software directs successive pointing to each header object and data block 224, so as to create a list of pointers that interleave the data blocks 224 for continuous downloading (Step 308). The software now executes a looping through of the list of pointers, an updating of header object and data block 224 system information, and can direct outputting of objects in their assigned order. However, because the DATABLKS.DAT file is being continuously updated, the software compares the loaded DATABLKS.DAT file (Step 302) with the version in memory (Step 310). If there is a difference, the software reinitiates Step 302 and proceeds. If there are no differences, the software returns to Step 308 and completes the operation. The IIRT 40 downloads a fresh copy of the TOC header before

downloading an object to verify that the TOC in IIRT memory is current. If the TOC in IIRT 40 memory is not current, the IIRT 40 downloads a new TOC into IIRT 40 memory.

Flowcharts for a method, using this invention, to request and pay for transmission of interactive data from a central processing station 20 are set out in figures 16A through 16C. The method begins with a user of IIRT unit 40 inputting a signal using remote control 52 or other signal generator to request specific interactive data (Step 402). This inputting of a request signal can be in response to selecting a particular item from a displayed menu, or from any range of information made available to IIRT unit 40 users.

The IIRT unit 40 will select the transmission modality for communicating with the central processing station 20, which can include use of modem 146 and telco 38. After the transmission modality is selected, the IIRT unit 40 transmits both the request signal and the identification code for the requesting IIRT unit 40 to the central processing station 20 (Step 406). Upon receipt of the IIRT unit 40 identification code and the request signal, the master computer 800 references a previously stored look-up table to determine whether the identified IIRT unit 40 is in good standing, e.g., all outstanding charges have been paid (Step 410). If the identified IIRT unit 40 is not in good standing, the central processing station 20 transmits an error report signal to the identified IIRT unit 40 for display (Step 411). In the alternative, if the identified IIRT unit 40 is in good standing, the master computer 800 proceeds to reference a second previously stored look-up table to determine the charge associated with transmission of the requested interactive data or service (Step 414). If there is a charge, then the amount of that charge is transmitted back to the IIRT unit 40 and displayed on television receiver 26 or LCD display 56. In response to this information, the user can initiate transmission to the central processing station 20 of a signal with credit card information using magnetic card reader 70. Upon receipt of the signal, the charge card information is validated as to whether the charge card is in

good standing for payment of the charge. This validation (Step 415) can be accomplished using the other goods & services gateway 876 as discussed above. If the charge card is not validated as being capable of covering the charge, then an error report is transmitted to the IIRT unit 40 (Step 417). For those situations when either no charge is made for the transmission or the transmitted charge card information is validated as being capable of covering the required payment, the master computer 800 proceeds to allocate for transmission the object address 504, data block identifier 226, next object channel 238, and delivery schedule (Step 416). This allocated information is now transmitted from the central processing station 20 to the IIRT unit 40 (Step 418). If the transmitted object is to be encrypted, then an encryption type code 232 is also transmitted to the IIRT unit 40. All preparations for transmission of the object are now completed and the object is transmitted to the IIRT unit 40 (Step 424).

If the transmitted object meets the previously identified delivery schedule (Step 426), and if there is no charge for the transmission (Step 428), then the process is complete. However, if the transmission did not meet the previously announced delivery schedule, then the IIRT unit 40 transmits an error signal to the central processing station 20 (Step 432) and delivery of the object is rescheduled (Step 434). To accomplish redelivery, the process must return to Step 418.

Again, if the transmission did meet the announced delivery schedule (Step 426) and there is a charge for the transmission (Step 428), then the IIRT unit 40 transmits a receipt validation code 426 to the central processing station 20 (Step 436). At this point actual payment is made. If Step 436 is not executed, no payment is made because the IIRT unit 40 has not acknowledged receipt of the requested interactive data. Finally, if required, the central processing station 20 transmits an encryption type code 232 so the received objects can be decrypted. Further, if

documents are to be printed, the necessary signals are transmitted to printer 60 (Step 438).

The above discussion and related illustrations of the present invention are directed primarily to a preferred embodiment and practices of the invention. However, it is believed that numerous changes and modifications in the actual implementation of the concepts described herein will be apparent to those skilled in the art, and it is contemplated that such changes and modifications may be made without departing from the scope of the invention as defined by the following claims.

What is claimed is:

1. An interactive communications system comprising:

a central processing station means for processing digital signal streams provided from memory means for transmission, and for receiving previously transmitted signals, processing said received signals for retransmission including converting analog received signals to digital signal streams;

an Integrated Interactive Receiver Tuner (IIRT) means for receiving and processing digital signal streams transmitted from said central processing station means, and for processing digital signal streams to be transmitted to said central processing station means;

wherein both said central processing station means and said IIRT means process each digital signal stream for transmission by determining a number of digital signal bits into which said digital signal stream is to be divided, so that each of the allocated number of digital signal bits are separated and included in objects for transmission, and then assembling each of said objects for transmission with a base class having one of the allocated number of digital signal bits included in each object within an object entity field.

2. An interactive communications system according to claim 1, wherein both of said central processing station means and said IIRT means can vary the number of digital signal bits included within object entity fields.

3. An interactive communications system according to claim 1, wherein different digital signal streams are to be transmitted and received, and the transmissions are organized so no two objects containing digital signal bits for the same digital signal stream are consecutively transmitted.

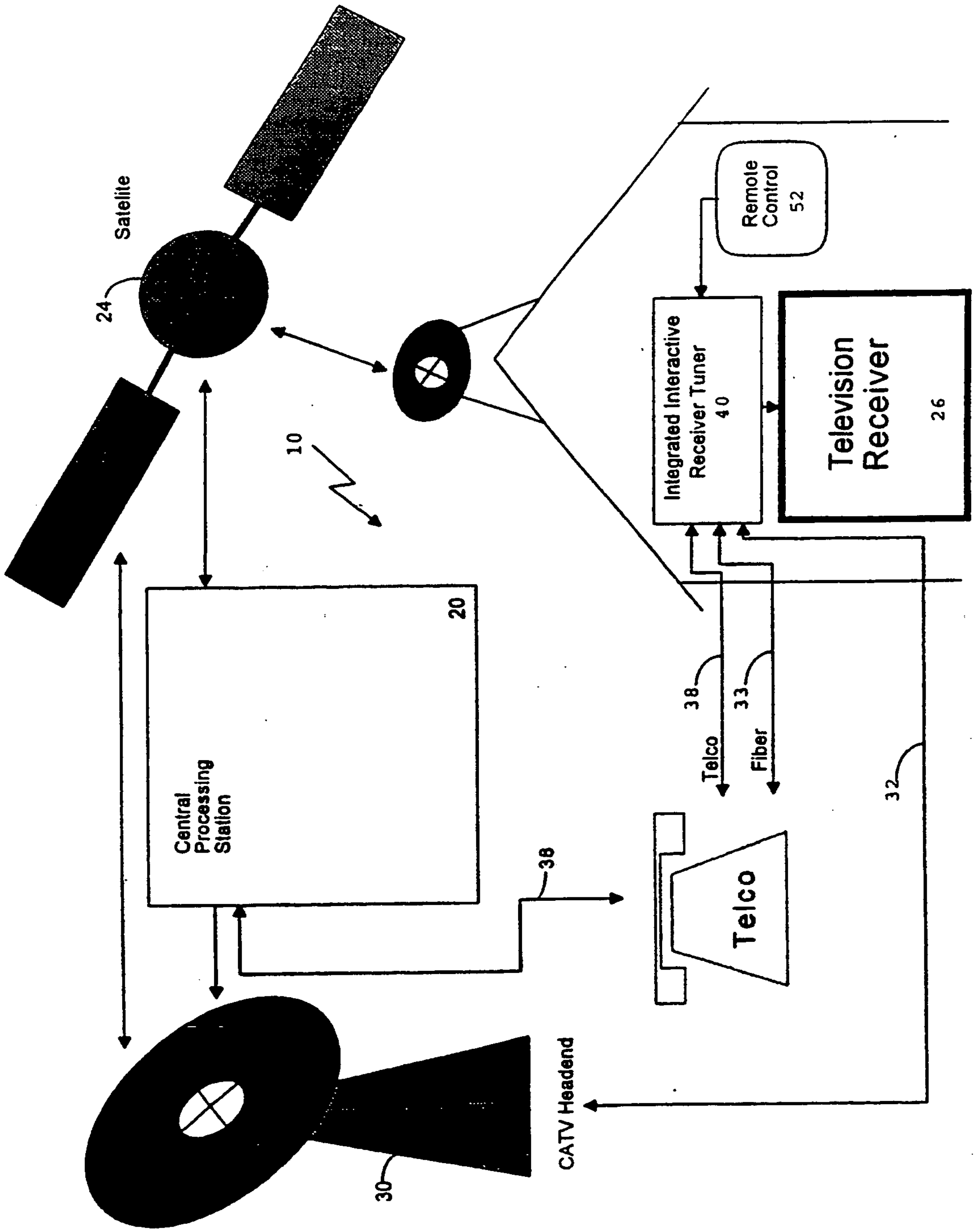
Satellite
24
10
20
Central Processing Station
Integrated Interactive Receiver Tuner
40
Remote Control
52
Television Receiver
26
38
33
Telco
Fiber
32
38
Telco
CATV Headend
30

Fig. 1

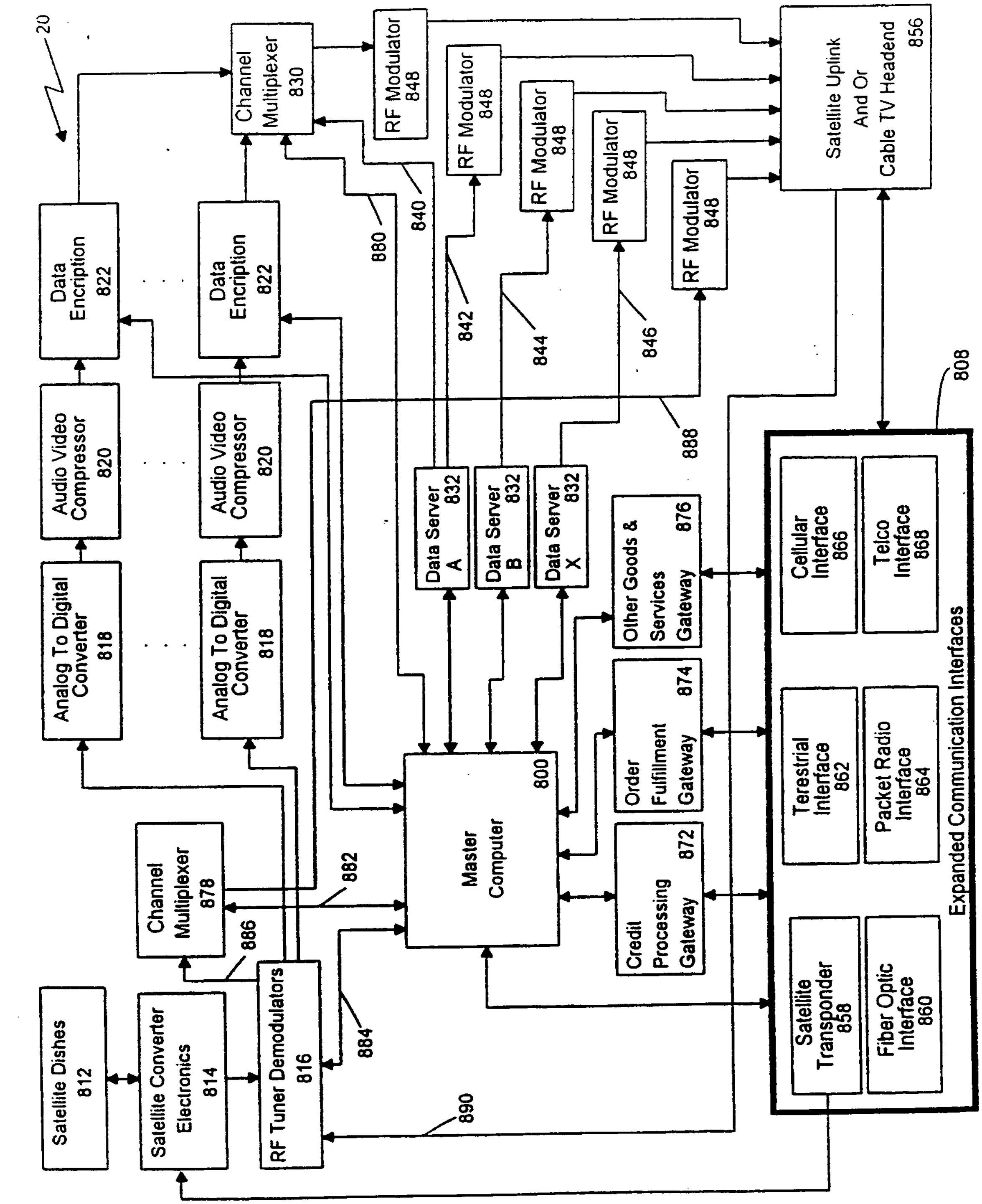
20
Satellite Dishes 812
Satellite Converter Electronics 814
RF Tuner Demodulators 816
Analog To Digital Converter 818
Audio Video Compressor 820
Data Encription 822
Channel Multiplexer 830
RF Modulator 848
Satellite Uplink And Or Cable TV Headend 856
Data Server A 832
Data Server B 832
Data Server X 832
Master Computer 800
Channel Multiplexer 878
Credit Processing Gateway 872
Order Fulfillment Gateway 874
Other Goods & Services Gateway 876
Satellite Transponder 858
Fiber Optic Interface 860
Terestrial Interface 862
Packet Radio Interface 864
Cellular Interface 866
Telco Interface 868
Expanded Communication Interfaces
808
840
842
844
846
880
882
884
886
888
890

Fig. 2

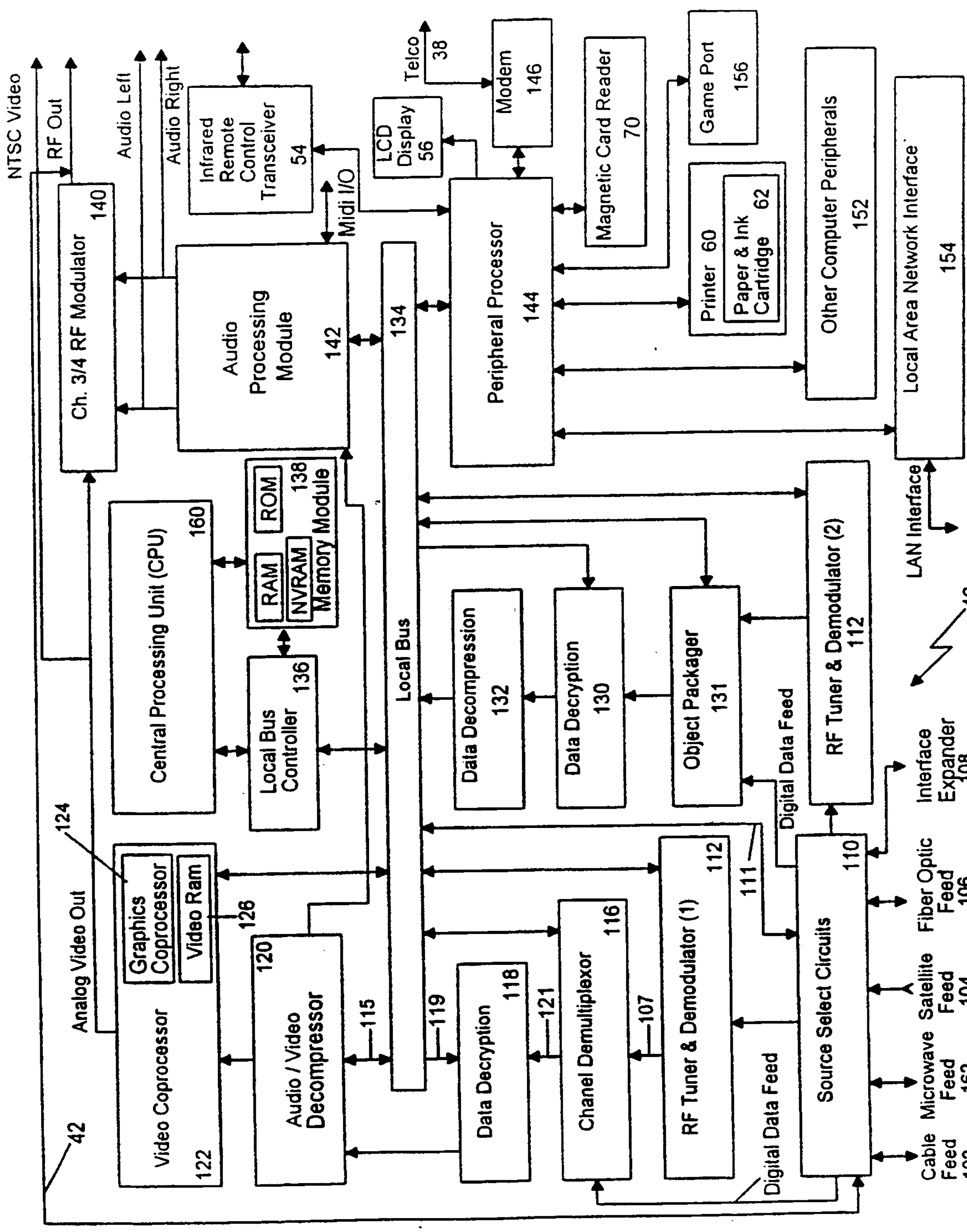
NTSC Video
RF Out
Audio Left
Audio Right
Infrared Remote Control Transceiver 54
Telco 38
Modem 146
LCD Display 56
Magnetic Card Reader 70
Game Port 156
Other Computer Peripherals 152
Local Area Network Interface 154
Printer 60
Paper & Ink Cartridge 62
Midi I/O
Ch. 3/4 RF Modulator 140
Audio Processing Module 142
Local Bus 134
Peripheral Processor 144
Central Processing Unit (CPU) 160
RAM
NVRAM
ROM
Memory Module 138
Local Bus Controller 136
Data Decompression 132
Data Decryption 130
Object Packager 131
RF Tuner & Demodulator (2) 112
LAN Interface
Digital Data Feed
40
Interface Expander 108
Analog Video Out
124
Graphics Coprocessor
Video Ram
126
Video Coprocessor 122
120
Audio / Video Decompressor
115
119
Data Decryption 118
121
Chanel Demultiplexor 116
107
RF Tuner & Demodulator (1) 112
111
Source Select Circuits 110
Fiber Optic Feed 106
Satellite Feed 104
Microwave Feed 162
Cable Feed 102
42

Fig. 3

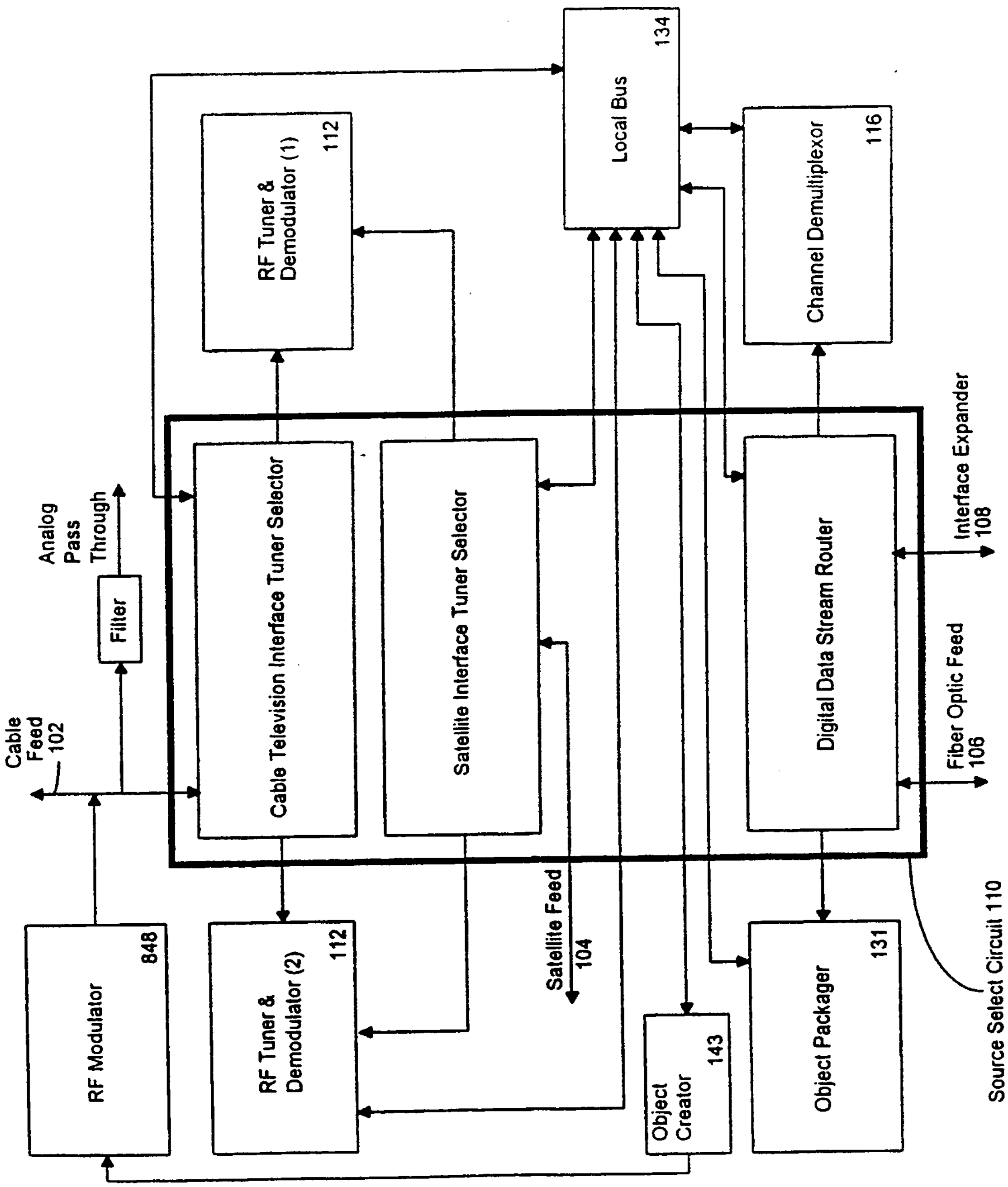
Local Bus
134
RF Tuner &
Demodulator (1)
112
Channel Demultiplexor
116
Analog
Pass
Through
Filter
Cable
Feed
102
Cable Television Interface Tuner Selector
Satellite Interface Tuner Selector
Digital Data Stream Router
Interface Expander
108
Fiber Optic Feed
106
RF Modulator
848
RF Tuner &
Demodulator (2)
112
Satellite Feed
104
Object
Creator
143
Object Packager
131
Source Select Circuit 110

Fig. 4A

RF Tuner & Demodulator (1)	RF Tuner & Demodulator (2)	Both
0	0	0
1	0	0
0	1	0
1	1	1

Fig. 4B

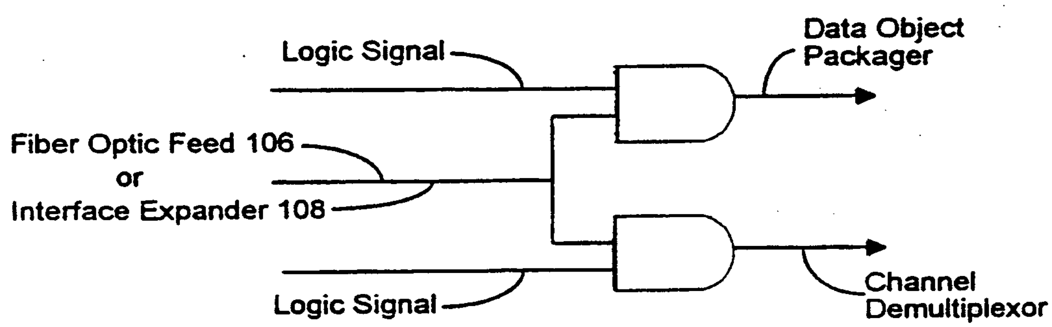

Fig. 4C

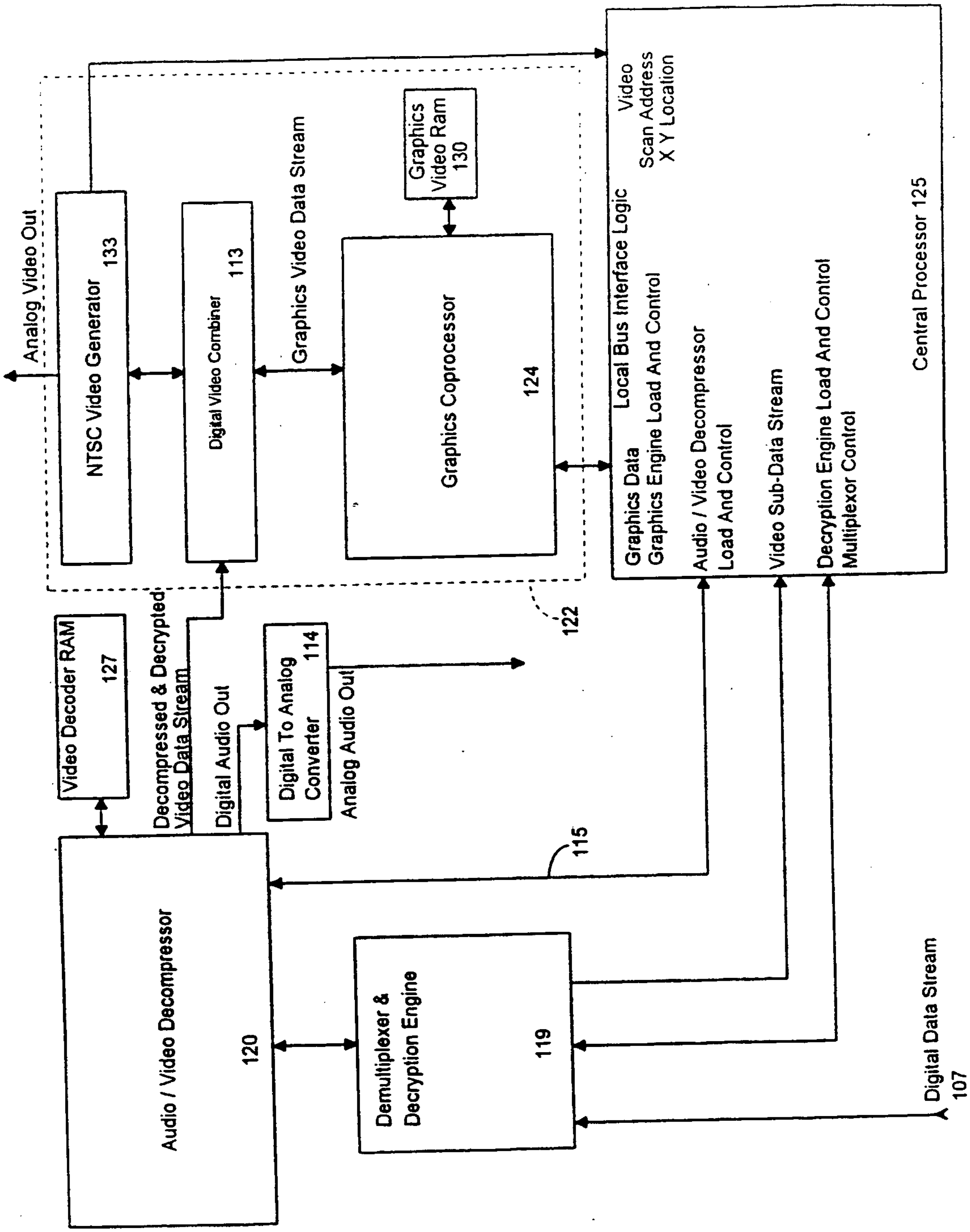
Analog Video Out
NTSC Video Generator 133
Digital Video Combiner 113
Graphics Video Data Stream
Graphics Video Ram 130
Graphics Coprocessor 124
122
Local Bus Interface Logic
Video Scan Address X Y Location
Graphics Data
Graphics Engine Load And Control
Audio / Video Decompressor Load And Control
Video Sub-Data Stream
Decryption Engine Load And Control
Multiplexor Control
Central Processor 125
Video Decoder RAM 127
Decompressed & Decrypted Video Data Stream
Digital Audio Out
Digital To Analog Converter 114
Analog Audio Out
115
Audio / Video Decompressor 120
Demultiplexer & Decryption Engine 119
Digital Data Stream 107

Fig. 5

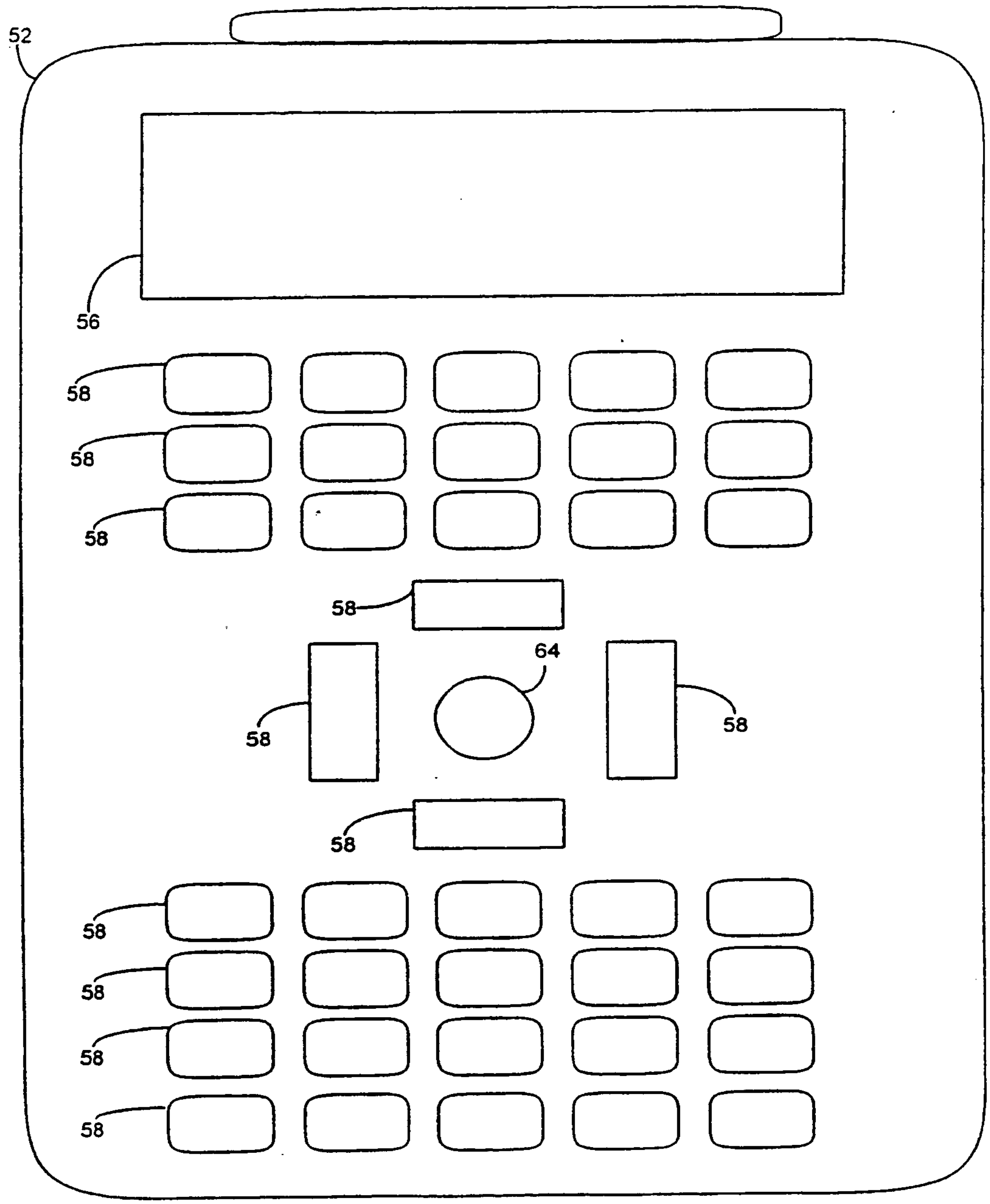

Fig. 6

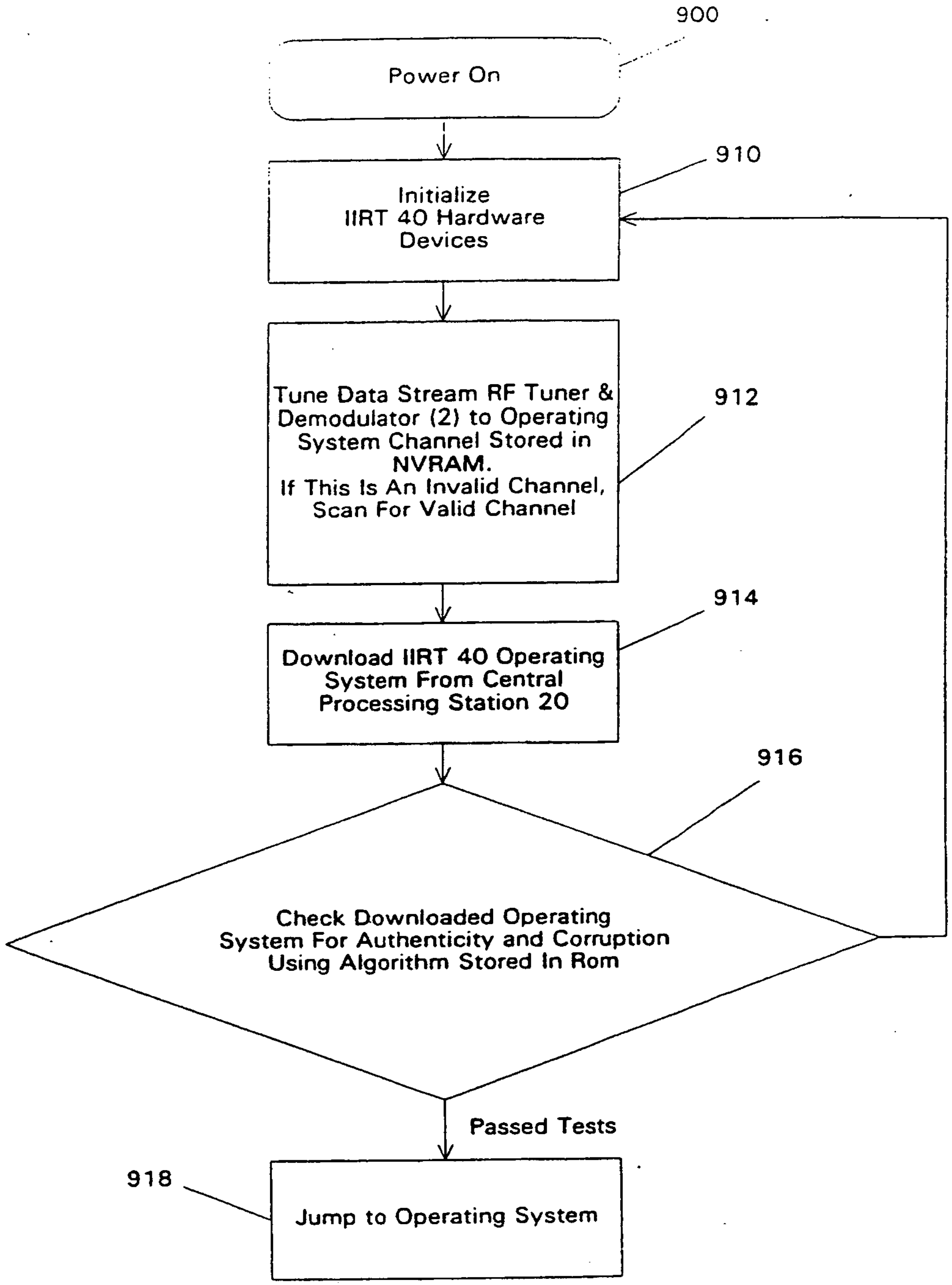
900
Power On
910
Initialize
IIRT 40 Hardware
Devices
Tune Data Stream RF Tuner &
Demodulator (2) to Operating
System Channel Stored in
NVRAM.
If This Is An Invalid Channel,
Scan For Valid Channel
912
Download IIRT 40 Operating
System From Central
Processing Station 20
914
916
Check Downloaded Operating
System For Authenticity and Corruption
Using Algorithm Stored In Rom
Passed Tests
918
Jump to Operating System

Fig. 7

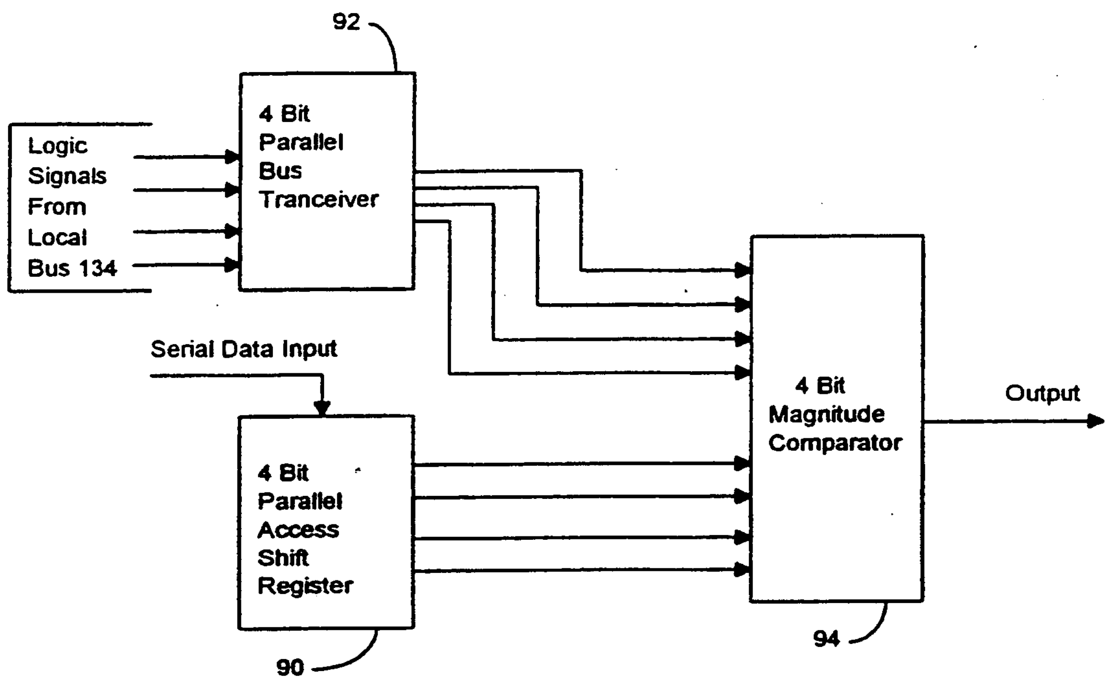
92
Logic
Signals
From
Local
Bus 134
4 Bit
Parallel
Bus
Tranceiver
Serial Data Input
4 Bit
Parallel
Access
Shift
Register
90
4 Bit
Magnitude
Comparator
94
Output

Fig. 8

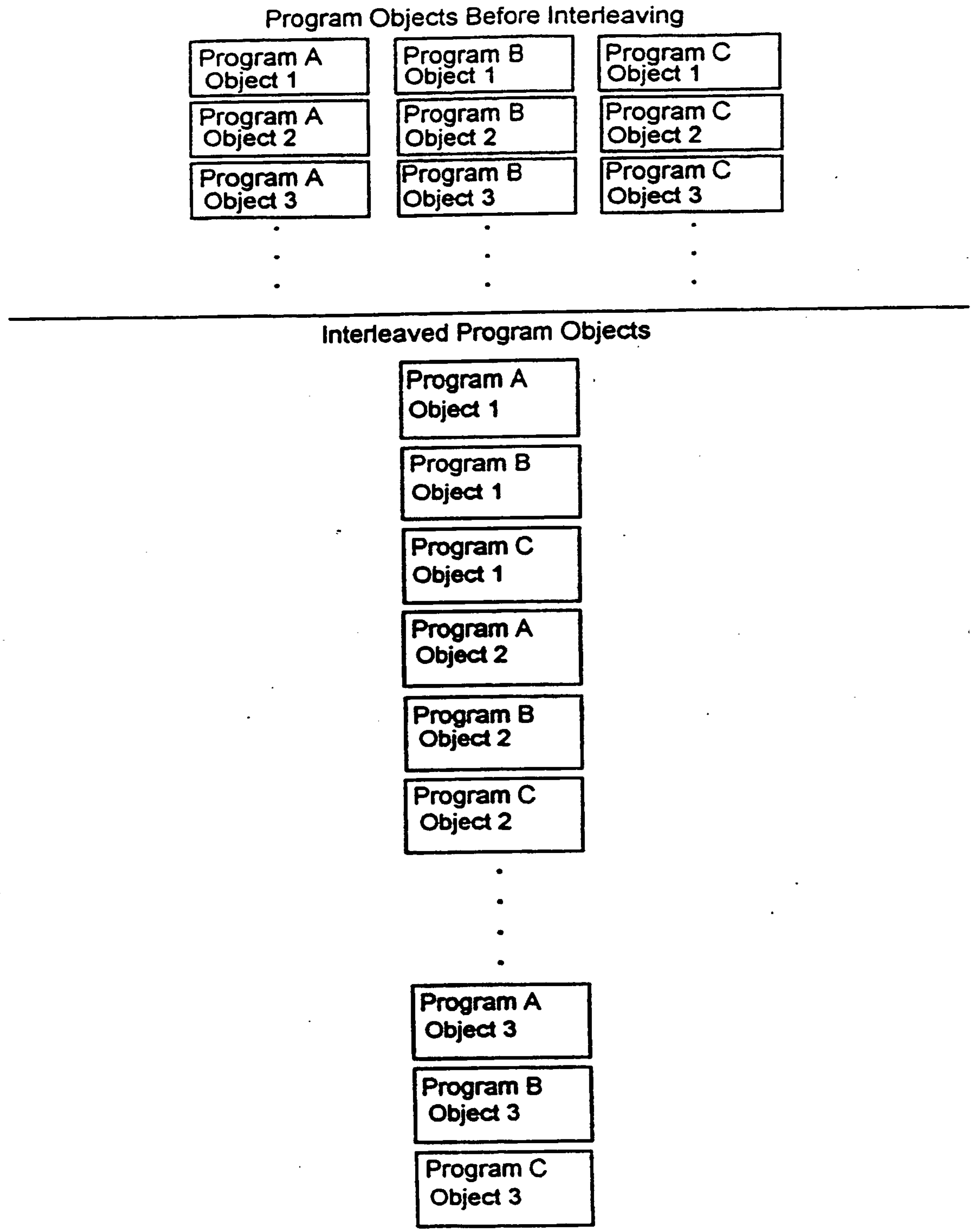
Program Objects Before Interleaving
Program A Object 1
Program A Object 2
Program A Object 3
Program B Object 1
Program B Object 2
Program B Object 3
Program C Object 1
Program C Object 2
Program C Object 3
Interleaved Program Objects
Program A Object 1
Program B Object 1
Program C Object 1
Program A Object 2
Program B Object 2
Program C Object 2
Program A Object 3
Program B Object 3
Program C Object 3

Fig. 9

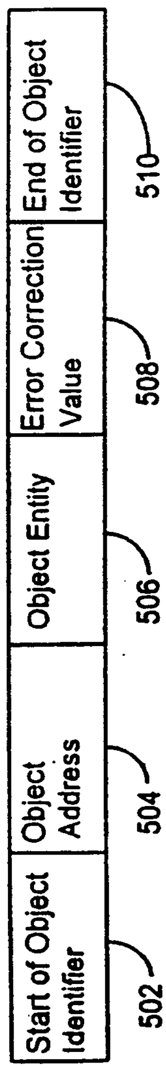
Start of Object Identifier
Object Address
Object Entity
Error Correction Value
End of Object Identifier
502
504
506
508
510

Fig. 10

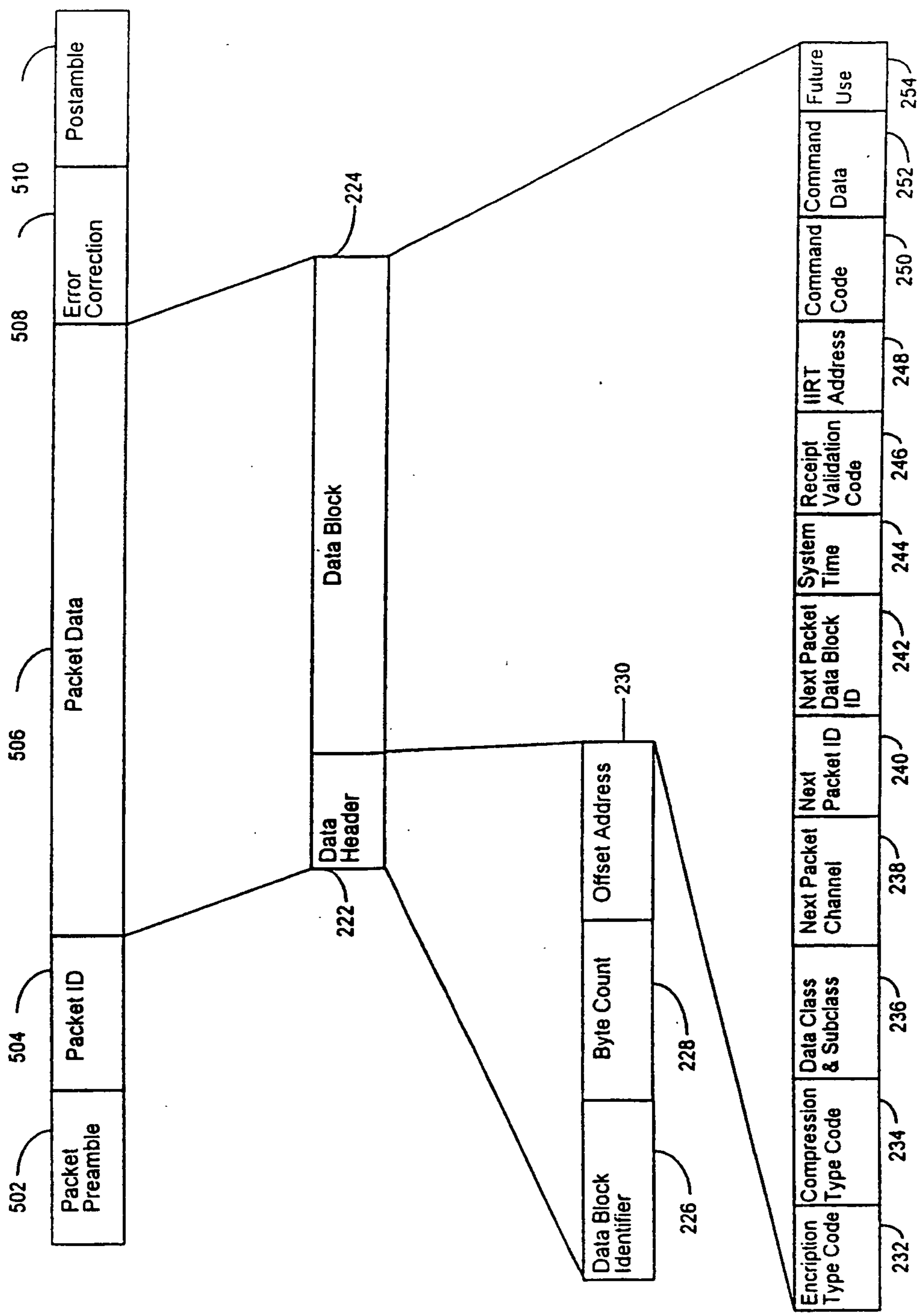
Packet Preamble
Packet ID
Packet Data
Error Correction
Postamble
502
504
506
508
510
Data Header
Data Block
222
224
Data Block Identifier
Byte Count
Offset Address
226
228
230
Encription Type Code
Compression Type Code
Data Class & Subclass
Next Packet Channel
Next Packet ID
Next Packet Data Block ID
System Time
Receipt Validation Code
IIRT Address
Command Code
Command Data
Future Use
232
234
236
238
240
242
244
246
248
250
252
254

Fig. 11

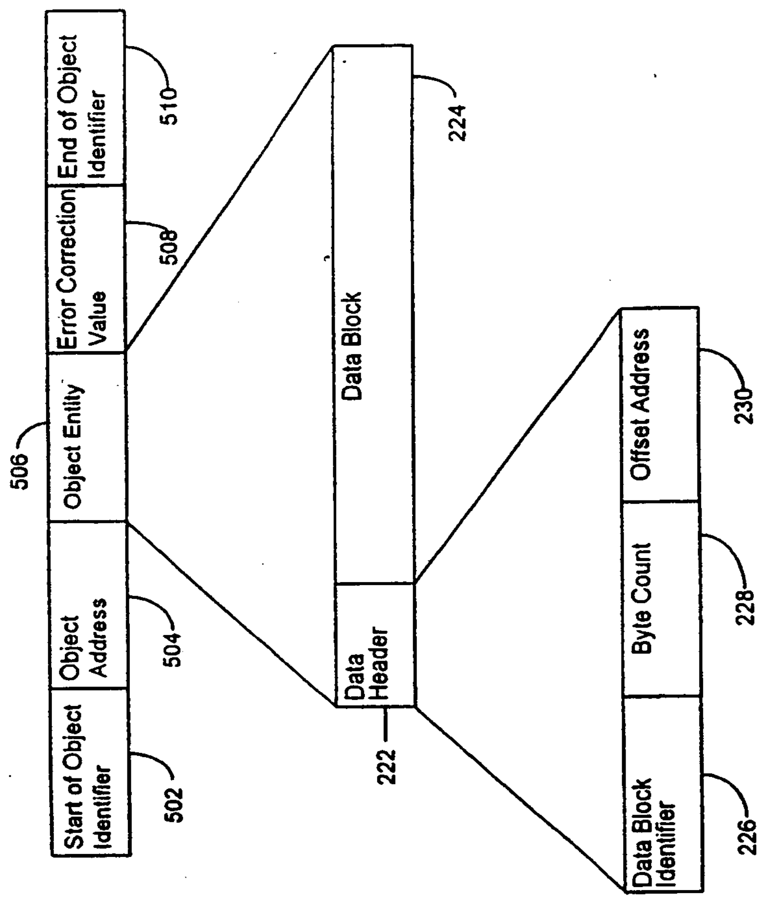
Start of Object Identifier
502
Object Address
504
Object Entity
506
Error Correction Value
508
End of Object Identifier
510
Data Header
222
Data Block
224
Data Block Identifier
226
Byte Count
228
Offset Address
230

Fig. 12

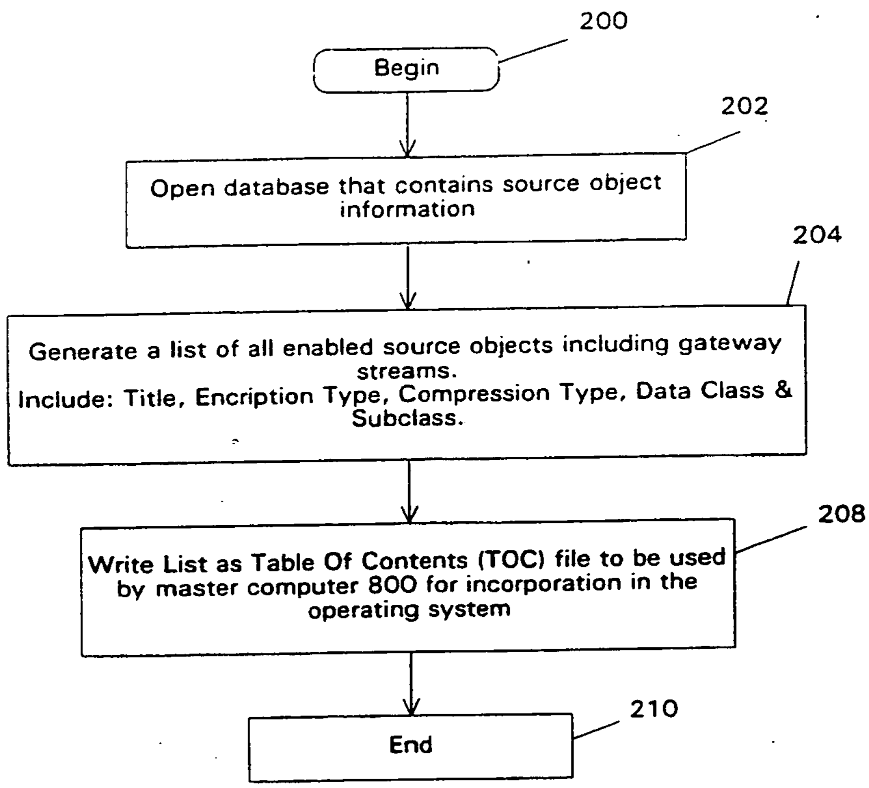
200
Begin
202
Open database that contains source object information
204
Generate a list of all enabled source objects including gateway streams.
Include: Title, Encription Type, Compression Type, Data Class & Subclass.
208
Write List as Table Of Contents (TOC) file to be used by master computer 800 for incorporation in the operating system
210
End

Fig. 13

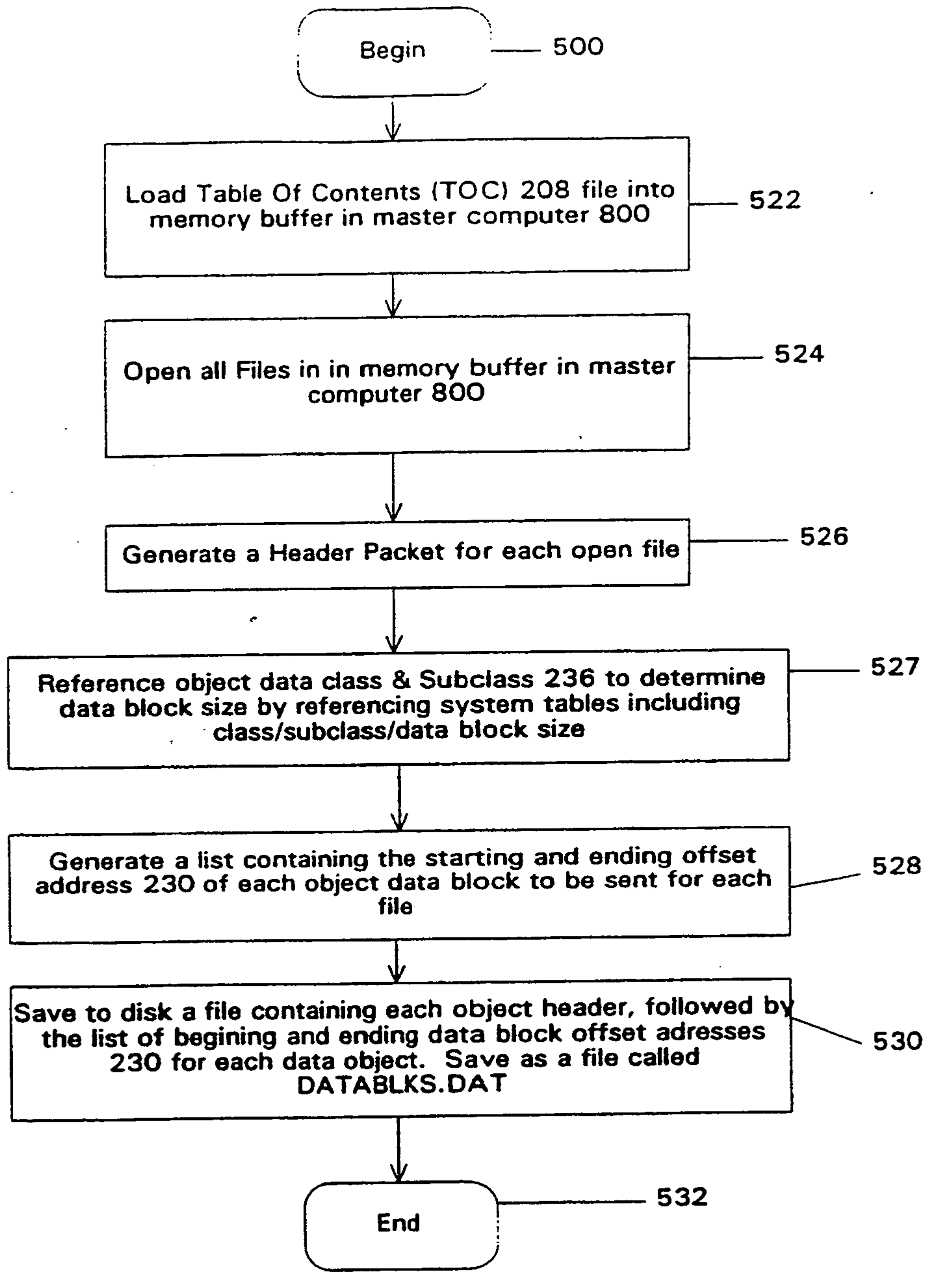
Begin
500
Load Table Of Contents (TOC) 208 file into memory buffer in master computer 800
522
Open all Files in in memory buffer in master computer 800
524
Generate a Header Packet for each open file
526
Reference object data class & Subclass 236 to determine data block size by referencing system tables including class/subclass/data block size
527
Generate a list containing the starting and ending offset address 230 of each object data block to be sent for each file
528
Save to disk a file containing each object header, followed by the list of begining and ending data block offset adresses 230 for each data object. Save as a file called DATABLKS.DAT
530
End
532

Fig 14

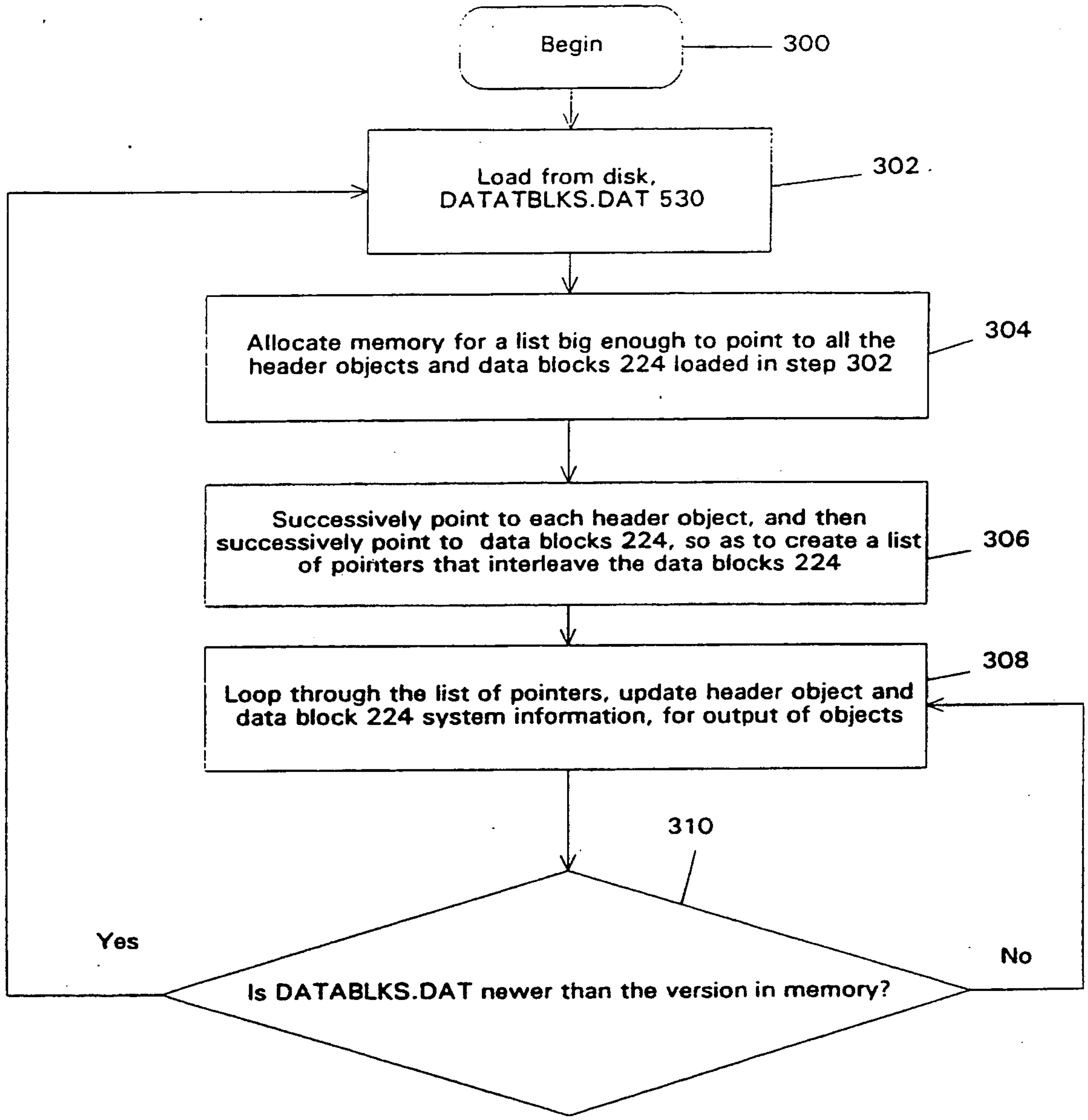
Begin
300
Load from disk, DATATBLKS.DAT 530
302
Allocate memory for a list big enough to point to all the header objects and data blocks 224 loaded in step 302
304
Successively point to each header object, and then successively point to data blocks 224, so as to create a list of pointers that interleave the data blocks 224
306
Loop through the list of pointers, update header object and data block 224 system information, for output of objects
308
310
Yes
No
Is DATABLKS.DAT newer than the version in memory?

Fig. 15

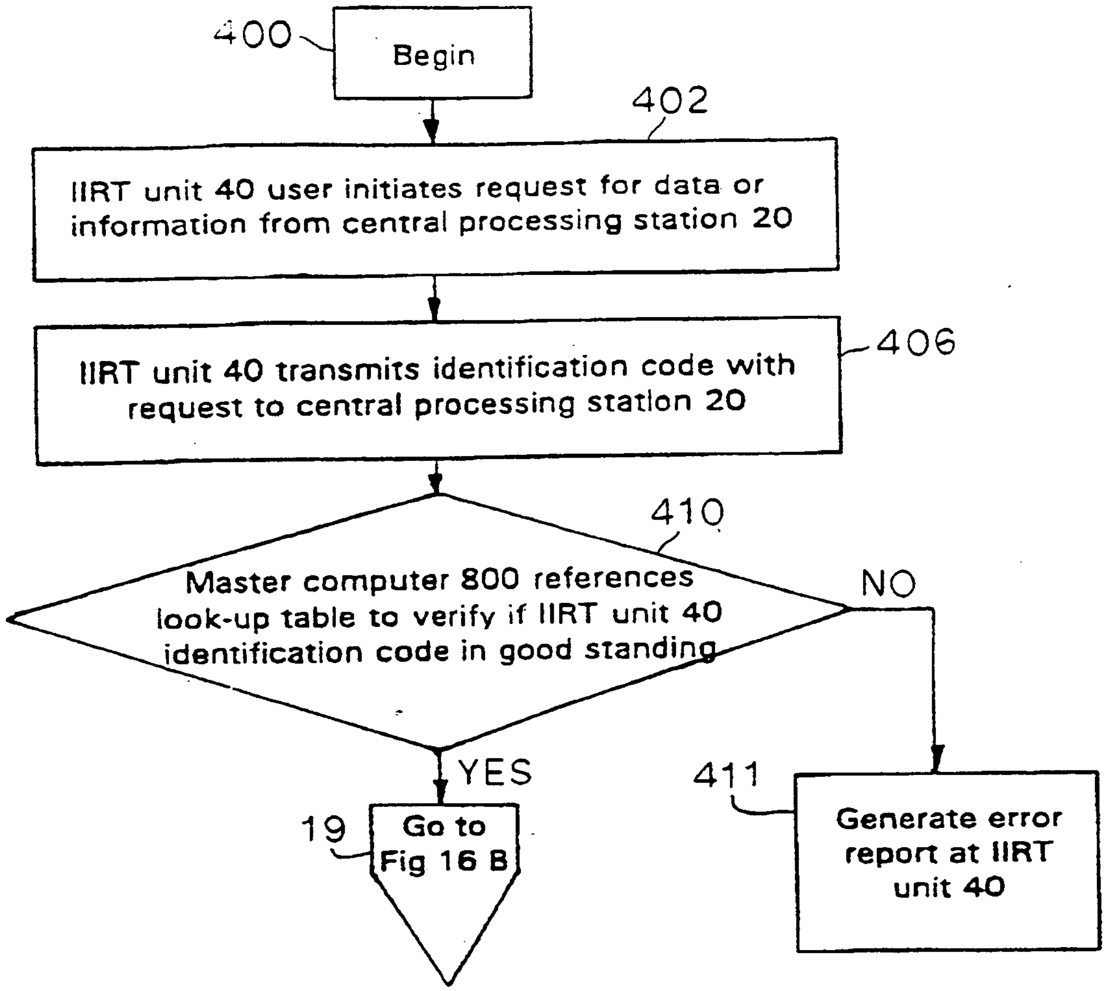
400
Begin
402
IIRT unit 40 user initiates request for data or information from central processing station 20
IIRT unit 40 transmits identification code with request to central processing station 20
406
410
Master computer 800 references look-up table to verify if IIRT unit 40 identification code in good standing
NO
YES
19
Go to Fig 16 B
411
Generate error report at IIRT unit 40

Fig. 16A

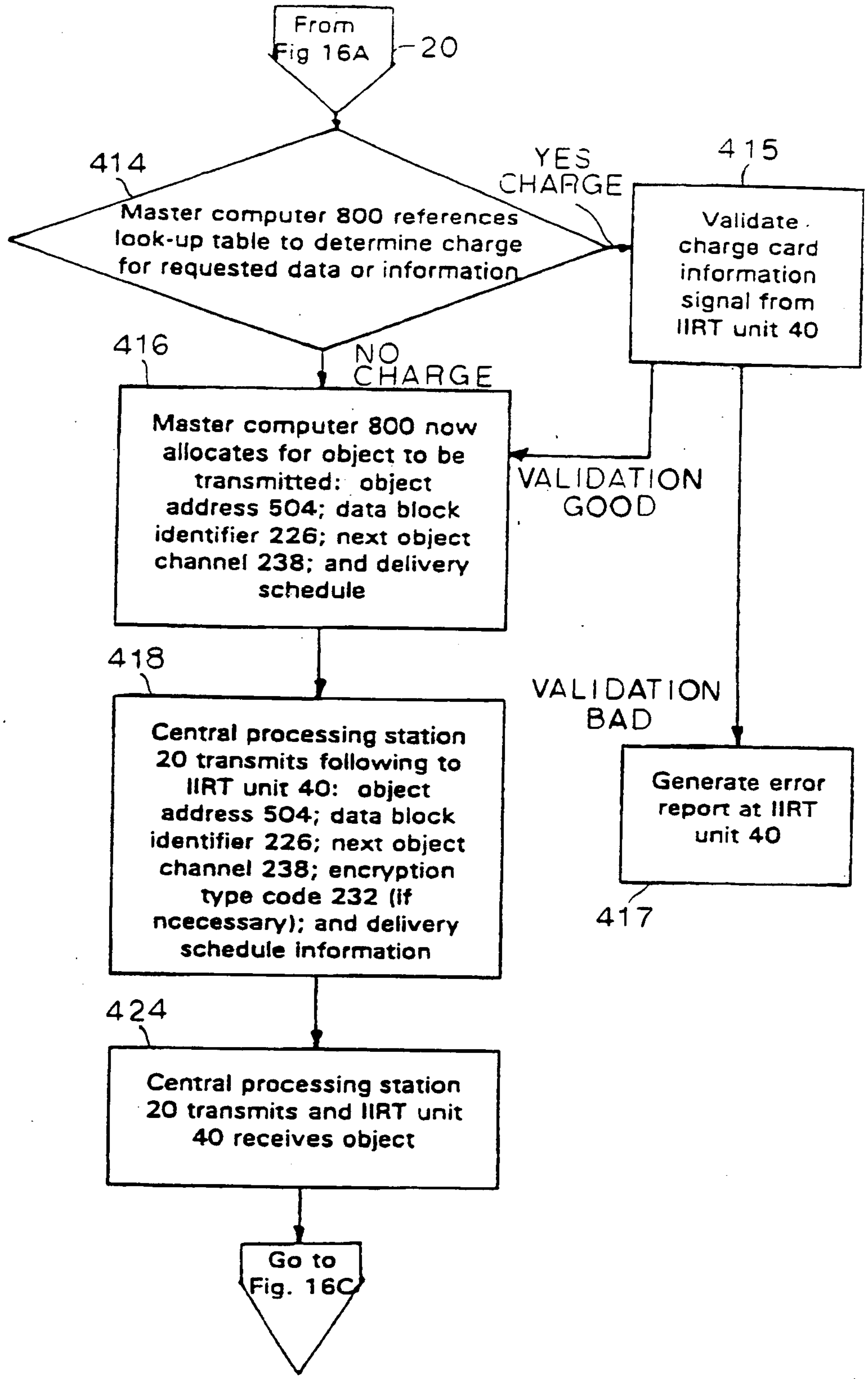
From
Fig 16A
20
414
Master computer 800 references look-up table to determine charge for requested data or information
YES
CHARGE
415
Validate charge card information signal from IIRT unit 40
416
NO
CHARGE
Master computer 800 now allocates for object to be transmitted: object address 504; data block identifier 226; next object channel 238; and delivery schedule
VALIDATION
GOOD
418
Central processing station 20 transmits following to IIRT unit 40: object address 504; data block identifier 226; next object channel 238; encryption type code 232 (if ncecessary); and delivery schedule information
VALIDATION
BAD
Generate error report at IIRT unit 40
417
424
Central processing station 20 transmits and IIRT unit 40 receives object
Go to
Fig. 16C

Fig. 16B

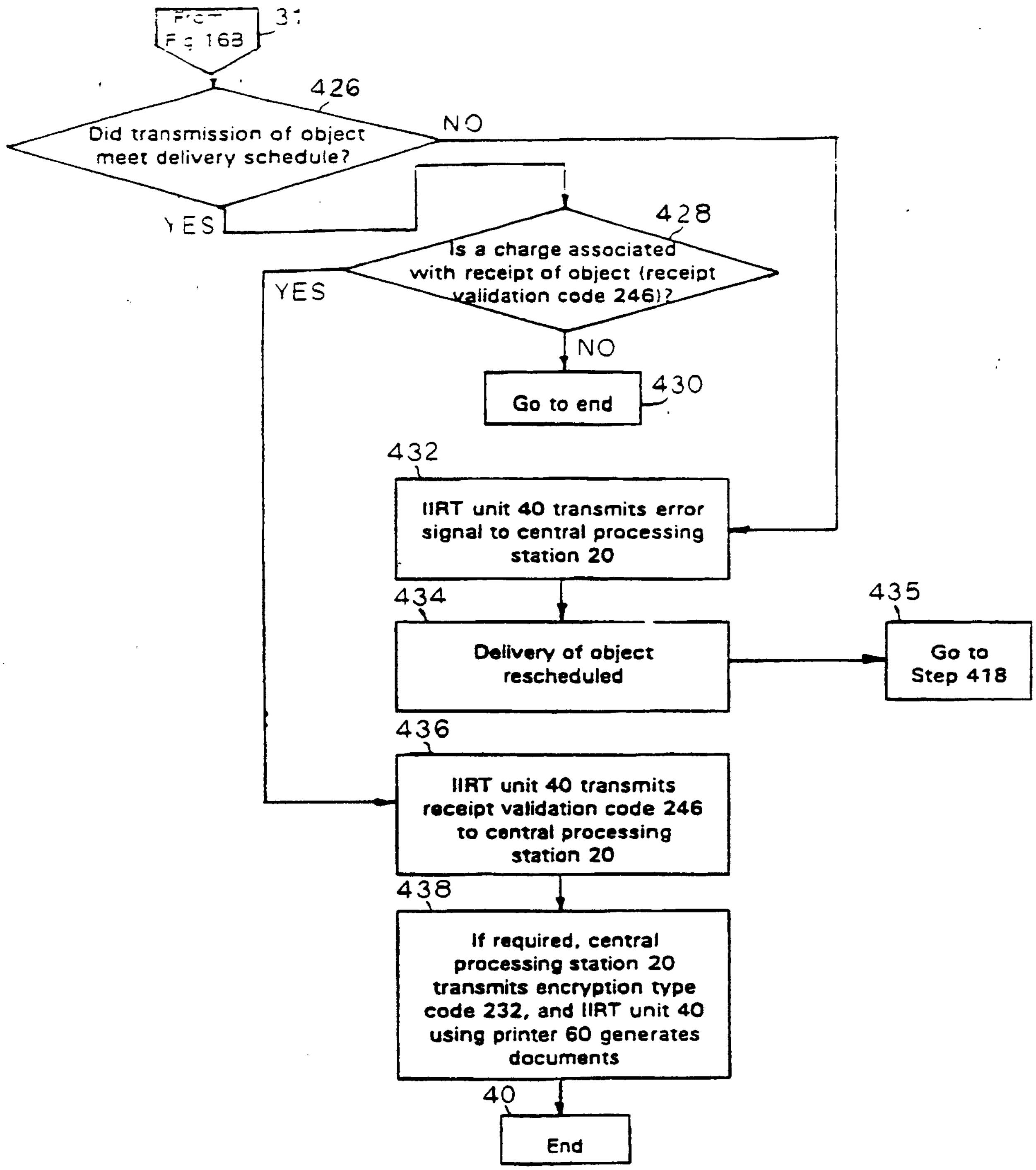
From Fig 16B
31
426
Did transmission of object meet delivery schedule?
NO
YES
428
Is a charge associated with receipt of object (receipt validation code 246)?
YES
NO
Go to end
430
432
IIRT unit 40 transmits error signal to central processing station 20
434
Delivery of object rescheduled
435
Go to Step 418
436
IIRT unit 40 transmits receipt validation code 246 to central processing station 20
438
If required, central processing station 20 transmits encryption type code 232, and IIRT unit 40 using printer 60 generates documents
40
End

Fig. 16C